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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

THE EPHEMERIS

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1986

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Prepared by
Nautical Almanac Office
United States Naval Observatory

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

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EPHEMERIS OF THE SUN, POLARIS AND OTHER SELECTED STARS

WITH COMPANION DATA AND TABLES

FOR THE YEAR

1986

A Supplement to the Manual of Instruction for the Survey of the Public Lands of the United States

SEVENTY-SEVENTH EDITION

Prepared by Nautical Almanac Office
United States Naval Observatory

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1985

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Washington, D.C. 20402

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PREFACE

The arrangement of the astronomical data herein conforms to the methods and examples for the determination of time, latitude, and azimuth, practiced by the cadastral engineers of the Bureau of Land Management. These practices are described in the Manual of Instructions for the Survey of the Public Lands of the United States.

The methods long in use have been developed for the best operation of the improved sola. transit, in combination with observations on the sun, Polaris, and the brighter equatorial stars, for the determination and verification of time, latitude, and azimuth. In this practice, the data for the *sun* are required in terms of daily *apparent positions* for the Greenwich meridian; for all *stellar* positions in terms of the Greenwich meridian, *mean time*, and *mean time intervals*.

The apparent time of sunrise and of sunset, the refractions in polar distance, and the companion trigonometric tables and formulas employed in these methods, are tabulated in the Standard Field Tables of the Bureau of Land Management.

Other Technical Publications

The Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, has for sale to the public at current cost of printing the following technical publications of the Bureau of Land Management.

The Manual of Instructions for the Survey of the Public Lands of the United States, 1973.

Standard Field Tables, 1956 (a supplement to the Manual of Surveying Instructions); contains traverse tables; stadia coefficients; 5-place natural and 6-place logarithmic sines, cosines, tangents, and cotangents; 6-place logarithms of numbers; and other tables and data of particular application in land surveying practice.

The Ephemeris, published annually.

Restoration of Lost or Obliterated Corners and Subdivisions of Sections, 1963 edition, reprint 1965; a compendium of the rules that are applicable within the area of the United States rectangular surveys, for the guidance of county and other local surveyors, with explanation of the methods relating to retracements.

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Date	AT GREENWICH APPARENT NOON: THE SUN'S Apparent Declination	Diff for 1 Hour	Semi-diameter	Time Semi-diameter Passing Mer.	Equation of Time, Add to Apparent Time	POLARIS FOR THE MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME: Upper Culmination	Elongation Lat. 40°	Declination +89°
	° ′ ″	″	′ ″	s	m s	h m	h m	′ ″
JANUARY, 1986								
Wed. 1	S23 00 19.3	+12.35	16 17.52	71	3 30.32	7 32.8 P.M.	W.E. 1 33.1 A.M.	12 24.03
Thur. 2	22 55 09.1	13.50	16 17.53	71	3 58.47	7 28.8	1 29.1	12 24.20
Fri. 3	22 49 31.4	14.64	16 17.52	71	4 26.29	7 24.9	1 25.2	12 24.35
Sat. 4	22 43 26.4	15.77	16 17.51	71	4 53.75	7 20.9	1 21.2	12 24.49
Sun. 5	22 36 54.4	16.90	16 17.50	71	5 20.83	7 17.0	1 17.3	12 24.63
Mon. 6	22 29 55.4	18.01	16 17.48	71	5 47.49	7 13.0	1 13.3	12 24.78
Tues. 7	22 22 29.7	19.12	16 17.46	71	6 13.71	7 09.1	1 09.4	12 24.94
Wed. 8	22 14 37.5	20.22	16 17.43	71	6 39.46	7 05.1	1 05.4	12 25.13
Thur. 9	22 06 19.0	21.31	16 17.40	71	7 04.69	7 01.2	1 01.5	12 25.33
Fri. 10	21 57 34.6	22.39	16 17.36	70	7 29.39	6 57.2	0 57.5	12 25.53
Sat. 11	21 48 24.4	23.46	16 17.33	70	7 53.51	6 53.2	0 53.6	12 25.72
Sun. 12	21 38 48.7	24.51	16 17.28	70	8 17.04	6 49.3	0 49.6	12 25.88
Mon. 13	21 28 47.8	25.55	16 17.24	70	8 39.95	6 45.3	0 45.6	12 26.02
Tues. 14	21 18 22.1	26.59	16 17.19	70	9 02.21	6 41.4	0 41.7	12 26.13
Wed. 15	21 07 31.7	27.60	16 17.14	70	9 23.80	6 37.4	0 37.7	12 26.21
Thur. 16	20 56 17.1	28.61	16 17.08	70	9 44.69	6 33.4	0 33.8	12 26.28
Fri. 17	20 44 38.5	29.60	16 17.02	70	10 04.88	6 29.5	0 29.8	12 26.34
Sat. 18	20 32 36.2	30.58	16 16.95	70	10 24.35	6 25.5	0 25.8	12 26.39
Sun. 19	20 20 10.7	31.54	16 16.88	70	10 43.07	6 21.6	0 21.9	12 26.44
Mon. 20	20 07 22.3	32.49	16 16.80	70	11 01.05	6 17.6	0 17.9	12 26.50
Tues. 21	19 54 11.3	33.42	16 16.72	69	11 18.26	6 13.7	0 14.0	12 26.57
Wed. 22	19 40 38.1	34.34	16 16.63	69	11 34.69	6 09.7	0 10.0	12 26.65
Thur. 23	19 26 43.1	35.24	16 16.54	69	11 50.34	6 05.8	0 06.1	12 26.73
Fri. 24	19 12 26.6	36.13	16 16.44	69	12 05.20	6 01.8	0 02.1 A.M. / 11 58.2 P.M.	12 26.82
Sat. 25	18 57 49.0	37.00	16 16.33	69	12 19.27	5 57.8	11 54.2	12 26.91
Sun. 26	18 42 50.6	37.86	16 16.22	69	12 32.53	5 53.9	11 50.2	12 26.98
Mon. 27	18 27 31.9	38.70	16 16.10	69	12 45.00	5 49.9	11 46.3	12 27.04
Tues. 28	18 11 53.1	39.52	16 15.98	69	12 56.66	5 46.0	11 42.3	12 27.07
Wed. 29	17 55 54.8	40.33	16 15.85	69	13 07.53	5 42.0	11 38.4	12 27.08
Thur. 30	17 39 37.1	41.13	16 15.71	68	13 17.59	5 38.0	11 34.4	12 27.06
Fri. 31	S17 23 00.5	+41.91	16 15.57	68	13 26.86	5 34.1 P.M.	W.E. 11 30.4 P.M.	12 27.03
FEBRUARY, 1986								
Sat. 1	S17 06 05.4	+42.68	16 15.43	68	13 35.32	5 30.1 P.M.	W.E. 11 26.5 P.M.	12 26.99
Sun. 2	16 48 52.1	43.42	16 15.28	68	13 42.99	5 26.2	11 22.5	12 26.95
Mon. 3	16 31 21.1	44.15	16 15.13	68	13 49.87	5 22.2	11 18.6	12 26.93
Tues. 4	16 13 32.7	44.87	16 14.97	68	13 55.95	5 18.3	11 14.6	12 26.93
Wed. 5	15 55 27.4	45.56	16 14.81	68	14 01.24	5 14.3	11 10.7	12 26.94
Thur. 6	15 37 05.6	46.24	16 14.64	68	14 05.73	5 10.4	11 06.7	12 26.96
Fri. 7	15 18 27.7	46.90	16 14.48	68	14 09.42	5 06.4	11 02.8	12 26.98
Sat. 8	14 59 34.2	47.55	16 14.31	67	14 12.33	5 02.4	10 58.8	12 26.97
Sun. 9	14 40 25.5	48.17	16 14.14	67	14 14.44	4 58.5	10 54.8	12 26.95
Mon. 10	14 21 02.0	48.78	16 13.96	67	14 15.77	4 54.5	10 50.9	12 26.89
Tues. 11	14 01 24.3	49.36	16 13.78	67	14 16.32	4 50.6	10 46.9	12 26.80
Wed. 12	13 41 32.6	49.93	16 13.60	67	14 16.08	4 46.6	10 43.0	12 26.70
Thur. 13	13 21 27.5	50.49	16 13.42	67	14 15.08	4 42.6	10 39.0	12 26.58
Fri. 14	13 01 09.3	51.02	16 13.24	67	14 13.32	4 38.7	10 35.0	12 26.45
Sat. 15	12 40 38.5	51.53	16 13.05	67	14 10.80	4 34.7	10 31.1	12 26.32
Sun. 16	S12 19 55.6	+52.03	16 12.86	67	14 07.54	4 30.8 P.M.	W.E. 10 27.1 P.M.	12 26.20

The sign + prefixed to the hourly change of declination indicates that { north / south } declinations are { increasing. / decreasing.

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Date	AT GREENWICH APPARENT NOON: THE SUN'S Apparent Declination	Diff. for 1 Hour	Semi-diameter	Time Semi-diameter Passing Mer.	Equation of Time, Add to Apparent Time	POLARIS FOR THE MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME: Upper Culmination	Elongation Lat. 40°	Declination +89°
FEBRUARY, 1986								
	° ′ ″	″	′ ″	s	m s	h m	h m	′ ″
Sun. 16	S12 19 55.6	+52.03	16 12.86	67	14 07.54	4 30.8 P.M.	W.E. 10 27.1 P.M.	12 26.20
Mon. 17	11 59 01.0	52.51	16 12.66	66	14 03.56	4 26.8	10 23.2	12 26.09
Tues. 18	11 37 55.0	52.98	16 12.46	66	13 58.86	4 22.9	10 19.2	12 25.98
Wed. 19	11 16 38.2	53.42	16 12.26	66	13 53.46	4 18.9	10 15.3	12 25.89
Thur. 20	10 55 10.9	53.85	16 12.05	66	13 47.37	4 15.0	10 11.3	12 25.80
Fri. 21	10 33 33.5	54.26	16 11.84	66	13 40.61	4 11.0	10 07.4	12 25.71
Sat. 22	10 11 46.5	54.65	16 11.63	66	13 33.20	4 07.0	10 03.4	12 25.62
Sun. 23	9 49 50.2	55.03	16 11.41	66	13 25.15	4 03.1	9 59.5	12 25.51
Mon. 24	9 27 45.0	55.39	16 11.19	66	13 16.49	3 59.1	9 55.5	12 25.38
Tues. 25	9 05 31.4	55.74	16 10.96	66	13 07.23	3 55.2	9 51.5	12 25.22
Wed. 26	8 43 09.6	56.07	16 10.73	66	12 57.41	3 51.2	9 47.6	12 25.04
Thur. 27	8 20 40.0	56.39	16 10.49	66	12 47.03	3 47.3	9 43.6	12 24.84
Fri. 28	S 7 58 03.1	+56.69	16 10.25	65	12 36.12	3 43.3 P.M.	W.E. 9 39.7 P.M.	12 24.64
MARCH, 1986								
Sat. 1	S 7 35 19.0	+56.97	16 10.01	65	12 24.70	3 39.4 P.M.	W.E. 9 35.7 P.M.	12 24.43
Sun. 2	7 12 28.3	57.24	16 09.76	65	12 12.79	3 35.4	9 31.8	12 24.24
Mon. 3	6 49 31.4	57.50	16 09.52	65	12 00.41	3 31.5	9 27.8	12 24.07
Tues. 4	6 26 28.5	57.74	16 09.26	65	11 47.58	3 27.5	9 23.9	12 23.92
Wed. 5	6 03 20.1	57.96	16 09.01	65	11 34.31	3 23.6	9 19.9	12 23.77
Thur. 6	5 40 06.6	58.16	16 08.76	65	11 20.63	3 19.6	9 16.0	12 23.63
Fri. 7	5 16 48.4	58.35	16 08.50	65	11 06.54	3 15.7	9 12.0	12 23.47
Sat. 8	4 53 25.9	58.52	16 08.24	65	10 52.07	3 11.7	9 08.1	12 23.29
Sun. 9	4 29 59.5	58.67	16 07.99	65	10 37.24	3 07.7	9 04.1	12 23.09
Mon. 10	4 06 29.7	58.81	16 07.73	65	10 22.05	3 03.8	9 00.2	12 22.86
Tues. 11	3 42 56.8	58.93	16 07.47	65	10 06.53	2 59.8	8 56.2	12 22.61
Wed. 12	3 19 21.3	59.03	16 07.21	65	9 50.69	2 55.9	8 52.3	12 22.35
Thur. 13	2 55 43.4	59.12	16 06.95	65	9 34.55	2 51.9	8 48.3	12 22.08
Fri. 14	2 32 03.7	59.19	16 06.69	65	9 18.12	2 48.0	8 44.4	12 21.81
Sat. 15	2 08 22.5	59.24	16 06.43	65	9 01.43	2 44.1	8 40.4	12 21.54
Sun. 16	1 44 40.2	59.28	16 06.17	65	8 44.49	2 40.1	8 36.5	12 21.28
Mon. 17	1 20 57.2	59.30	16 05.91	65	8 27.33	2 36.2	8 32.5	12 21.04
Tues. 18	0 57 13.8	59.30	16 05.65	65	8 09.95	2 32.2	8 28.6	12 20.80
Wed. 19	0 33 30.6	59.30	16 05.38	65	7 52.39	2 28.3	8 24.6	12 20.58
Thur. 20	S 0 09 47.7	59.27	16 05.12	65	7 34.66	2 24.3	8 20.7	12 20.36
Fri. 21	N 0 13 54.4	59.23	16 04.85	65	7 16.78	2 20.4	8 16.7	12 20.14
Sat. 22	0 37 35.3	59.17	16 04.58	64	6 58.77	2 16.4	8 12.8	12 19.91
Sun. 23	1 01 14.8	59.10	16 04.31	64	6 40.67	2 12.5	8 08.8	12 19.67
Mon. 24	1 24 52.3	59.02	16 04.04	64	6 22.48	2 08.5	8 04.9	12 19.41
Tues. 25	1 48 27.8	58.92	16 03.77	64	6 04.24	2 04.6	8 00.9	12 19.12
Wed. 26	2 12 00.7	58.81	16 03.49	64	5 45.96	2 00.6	7 57.0	12 18.81
Thur. 27	2 35 30.8	58.69	16 03.22	64	5 27.68	1 56.7	7 53.1	12 18.49
Fri. 28	2 58 57.8	58.56	16 02.94	64	5 09.41	1 52.8	7 49.1	12 18.18
Sat. 29	3 22 21.5	58.41	16 02.66	64	4 51.19	1 48.8	7 45.2	12 17.88
Sun. 30	3 45 41.7	58.24	16 02.37	64	4 33.03	1 44.9	7 41.2	12 17.60
Mon. 31	4 08 57.2	58.07	16 02.09	64	4 14.95	1 40.9	7 37.3	12 17.34
Tues. 32	N 4 32 08.6	+57.88	16 01.81	64	3 56.98	1 37.0 P.M.	W.E. 7 33.4 P.M.	12 17.10

The sign + prefixed to the hourly change of declination indicates that { north / south } declinations are { increasing / decreasing }.

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Date	AT GREENWICH APPARENT NOON: THE SUN'S Apparent Declination	Diff. for 1 Hour	Semi-diameter	Time Semi-diameter Passing Mer.	Equation of Time, Add to / Subtract from Apparent Time	POLARIS FOR THE MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME: Upper Culmination	Elongation Lat. 40°	Declination
								+89°
APRIL, 1986								
Tues. 1	N 4 32 08.6	+57.88	16 01.81	64	3 56.98	1 37.0 P.M.	W.E. 7 33.4 P.M.	12 17.10
Wed. 2	4 55 15.3	57.67	16 01.52	65	3 39.13	1 33.1	7 29.4	12 16.86
Thur. 3	5 18 16.8	57.45	16 01.24	65	3 21.43	1 29.1	7 25.5	12 16.62
Fri. 4	5 41 12.9	57.21	16 00.96	65	3 03.89	1 25.2	7 21.5	12 16.36
Sat. 5	6 04 03.1	56.96	16 00.68	65	2 46.53	1 21.2	7 17.6	12 16.08
Sun. 6	6 26 47.1	56.70	16 00.40	65	2 29.36	1 17.3	7 13.7	12 15.78
Mon. 7	6 49 24.5	56.42	16 00.12	65	2 12.41	1 13.4	7 09.7	12 15.46
Tues. 8	7 11 55.0	56.12	15 59.84	65	1 55.67	1 09.4	7 05.8	12 15.12
Wed. 9	7 34 18.2	55.81	15 59.57	65	1 39.18	1 05.5	7 01.8	12 14.78
Thur. 10	7 56 33.7	55.48	15 59.30	65	1 22.95	1 01.5	6 57.9	12 14.43
Fri. 11	8 18 41.3	55.14	15 59.03	65	1 06.98	12 57.6	6 54.0	12 14.10
Sat. 12	8 40 40.4	54.78	15 58.76	65	0 51.29	12 53.7	6 50.0	12 13.77
Sun. 13	9 02 30.8	54.41	15 58.49	65	0 35.90	12 49.7	6 46.1	12 13.46
Mon. 14	9 24 12.1	54.02	15 58.22	65	0 20.81	12 45.8	6 42.2	12 13.17
Tues. 15	9 45 43.9	53.62	15 57.96	65	0 06.05	12 41.9	6 38.2	12 12.89
Wed. 16	10 07 06.0	53.21	15 57.70	65	0 08.37	12 38.0	6 34.3	12 12.61
Thur. 17	10 28 17.9	52.78	15 57.44	65	0 22.44	12 34.0	6 30.4	12 12.35
Fri. 18	10 49 19.3	52.33	15 57.18	65	0 36.15	12 30.1	6 26.4	12 12.08
Sat. 19	11 10 09.9	51.88	15 56.92	65	0 49.48	12 26.1	6 22.5	12 11.80
Sun. 20	11 30 49.3	51.40	15 56.66	65	1 02.42	12 22.2	6 18.6	12 11.51
Mon. 21	11 51 17.2	50.92	15 56.41	65	1 14.95	12 18.3	6 14.6	12 11.20
Tues. 22	12 11 33.4	50.42	15 56.15	65	1 27.05	12 14.3	6 10.7	12 10.87
Wed. 23	12 31 37.5	49.91	15 55.90	65	1 38.71	12 10.4	6 06.8	12 10.52
Thur. 24	12 51 29.2	49.39	15 55.64	66	1 49.92	12 06.5	6 02.8	12 10.18
Fri. 25	13 11 08.2	48.86	15 55.39	66	2 00.66	12 02.6 P.M.	W.E. 5 58.9 P.M.	12 09.85
Sat. 26	13 30 34.3	48.31	15 55.13	66	2 10.91	11 58.6 A.M.	E.E. 6 02.3 A.M.	12 09.55
Sun. 27	13 49 47.2	47.76	15 54.88	66	2 20.65	11 54.7	5 58.4	12 09.27
Mon. 28	14 08 46.6	47.19	15 54.63	66	2 29.88	11 50.8	5 54.4	12 09.01
Tues. 29	14 27 32.1	46.60	15 54.38	66	2 38.59	11 46.9	5 50.5	12 06.77
Wed. 30	N14 46 03.4	+46.00	15 54.13	66	2 46.76	11 42.9 A.M.	E.E. 5 46.6 A.M.	12 08.53
MAY, 1986								
Thur. 1	N15 04 20.3	+45.39	15 53.88	66	2 54.38	11 39.0 A.M.	E.E. 5 42.7 A.M.	12 08.27
Fri. 2	15 22 22.4	44.77	15 53.63	66	3 01.44	11 35.1	5 38.7	12 08.00
Sat. 3	15 40 09.3	44.13	15 53.39	66	3 07.94	11 31.1	5 34.8	12 07.71
Sun. 4	15 57 40.7	43.48	15 53.15	66	3 13.88	11 27.2	5 30.9	12 07.40
Mon. 5	16 14 56.3	42.81	15 52.91	66	3 19.25	11 23.3	5 26.9	12 07.08
Tues. 6	16 31 55.7	42.13	15 52.68	66	3 24.04	11 19.4	5 23.0	12 06.75
Wed. 7	16 48 38.7	41.44	15 52.45	67	3 28.26	11 15.4	5 19.1	12 06.43
Thur. 8	17 05 04.9	40.74	15 52.23	67	3 31.91	11 11.5	5 15.2	12 06.11
Fri. 9	17 21 14.0	40.02	15 52.01	67	3 34.99	11 07.6	5 11.3	12 05.80
Sat. 10	17 37 05.7	39.28	15 51.79	67	3 37.50	11 03.7	5 07.3	12 05.51
Sun. 11	17 52 39.7	38.54	15 51.58	67	3 39.44	10 59.8	5 03.4	12 05.24
Mon. 12	18 07 55.6	37.78	15 51.37	67	3 40.81	10 55.8	4 59.5	12 04.98
Tues. 13	18 22 53.2	37.01	15 51.16	67	3 41.62	10 51.9	4 55.6	12 04.74
Wed. 14	18 37 32.2	36.23	15 50.96	67	3 41.87	10 48.0	4 51.7	12 04.51
Thur. 15	18 51 52.2	35.43	15 50.76	67	3 41.57	10 44.1	4 47.7	12 04.28
Fri. 16	N19 05 53.0	+34.63	15 50.57	67	3 40.72	10 40.2 A.M.	E.E. 4 43.8 A.M.	12 04.05

The sign + prefixed to the hourly change of declination indicates that { north / south } declinations are { increasing. / decreasing.

For time of Western Elongation of Polaris for any date after April 25th, add $5^h\ 56.4^m$ to the time of Upper Culmination of the same date.

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Date	AT GREENWICH APPARENT NOON: THE SUN'S Apparent Declination	Diff. for 1 Hour	Semi-diameter	Time Semi-diameter Passing Mer.	Equation of Time, Subtract from / Add to Apparent Time	POLARIS FOR THE MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME: Upper Culmination	Elongation Lat. 40°	Declination
	° ′ ″	″	′ ″	s	m s	h m	h m	+89° ′ ″
MAY, 1986								
Fri. 16	N19 05 53.0	+34.63	15 50.57	67	3 40.72	10 40.2 A.M.	E.E. 4 43.8 A.M.	12 04.05
Sat. 17	19 19 34.3	33.81	15 50.37	67	3 39.32	10 36.2	4 39.9	12 03.80
Sun. 18	19 32 55.9	32.98	15 50.19	67	3 37.39	10 32.3	4 36.0	12 03.55
Mon. 19	19 45 57.4	32.14	15 50.00	67	3 34.92	10 28.4	4 32.1	12 03.28
Tues. 20	19 58 38.7	31.29	15 49.82	68	3 31.92	10 24.5	4 28.1	12 03.00
Wed. 21	20 10 59.4	30.43	15 49.64	68	3 28.39	10 20.6	4 24.2	12 02.71
Thur. 22	20 22 59.4	29.56	15 49.46	68	3 24.34	10 16.6	4 20.3	12 02.43
Fri. 23	20 34 38.5	28.69	15 49.28	68	3 19.77	10 12.7	4 16.4	12 02.17
Sat. 24	20 45 56.4	27.80	15 49.11	68	3 14.69	10 08.8	4 12.5	12 01.94
Sun. 25	20 56 53.0	26.91	15 48.94	68	3 09.10	10 04.9	4 08.6	12 01.75
Mon. 26	21 07 28.1	26.01	15 48.77	68	3 03.01	10 01.0	4 04.7	12 01.57
Tues. 27	21 17 41.3	25.10	15 48.60	68	2 56.42	9 57.1	4 00.7	12 01.41
Wed. 28	21 27 32.6	24.17	15 48.43	68	2 49.35	9 53.2	3 56.8	12 01.24
Thur. 29	21 37 01.7	23.24	15 48.27	68	2 41.80	9 49.2	3 52.9	12 01.05
Fri. 30	21 46 08.4	22.31	15 48.11	68	2 33.78	9 45.3	3 49.0	12 00.85
Sat. 31	N21 54 52.4	+21.36	15 47.96	68	2 25.31	9 41.4 A.M.	E.E. 3 45.1 A.M.	12 00.63
JUNE, 1986								
Sun. 1	N22 03 13.6	+20.40	15 47.81	68	2 16.41	9 37.5 A.M.	E.E. 3 41.2 A.M.	12 00.40
Mon. 2	22 11 11.7	19.44	15 47.66	68	2 07.09	9 33.6	3 37.2	12 00.15
Tues. 3	22 18 46.7	18.47	15 47.52	68	1 57.37	9 29.7	3 33.3	11 59.91
Wed. 4	22 25 58.2	17.49	15 47.39	69	1 47.28	9 25.8	3 29.4	11 59.68
Thur. 5	22 32 46.2	16.51	15 47.25	69	1 36.82	9 21.8	3 25.5	11 59.46
Fri. 6	22 39 10.6	15.52	15 47.13	69	1 26.03	9 17.9	3 21.6	11 59.26
Sat. 7	22 45 11.0	14.52	15 47.01	69	1 14.93	9 14.0	3 17.7	11 59.08
Sun. 8	22 50 47.5	13.52	15 46.89	69	1 03.54	9 10.1	3 13.8	11 58.92
Mon. 9	22 55 59.8	12.51	15 46.78	69	0 51.88	9 06.2	3 09.9	11 58.77
Tues. 10	23 00 48.0	11.50	15 46.67	69	0 39.99	9 02.3	3 06.0	11 58.64
Wed. 11	23 05 11.7	10.48	15 46.57	69	0 27.87	8 58.4	3 02.0	11 58.51
Thur. 12	23 09 11.1	9.46	15 46.48	69	0 15.57	8 54.5	2 58.1	11 58.38
Fri. 13	23 12 45.9	8.44	15 46.39	69	0 03.09	8 50.6	2 54.2	11 58.25
Sat. 14	23 15 56.1	7.41	15 46.30	69	0 09.52	8 46.6	2 50.3	11 58.11
Sun. 15	23 18 41.6	6.38	15 46.22	69	0 22.25	8 42.7	2 46.4	11 57.95
Mon. 16	23 21 02.3	5.35	15 46.14	69	0 35.08	8 38.8	2 42.5	11 57.78
Tues. 17	23 22 58.4	4.32	15 46.07	69	0 47.97	8 34.9	2 38.6	11 57.61
Wed. 18	23 24 29.6	3.28	15 46.00	69	1 00.91	8 31.0	2 34.7	11 57.44
Thur. 19	23 25 36.0	2.25	15 45.93	69	1 13.89	8 27.1	2 30.8	11 57.29
Fri. 20	23 26 17.7	1.22	15 45.87	69	1 26.86	8 23.2	2 26.9	11 57.16
Sat. 21	23 26 34.6	+ 0.19	15 45.81	69	1 39.83	8 19.3	2 23.0	11 57.07
Sun. 22	23 26 26.7	− 0.84	15 45.75	69	1 52.76	8 15.4	2 19.0	11 57.01
Mon. 23	23 25 54.1	1.87	15 45.70	69	2 05.65	8 11.5	2 15.1	11 56.97
Tues. 24	23 24 56.9	2.90	15 45.65	69	2 18.46	8 07.6	2 11.2	11 56.93
Wed. 25	23 23 34.9	3.93	15 45.60	69	2 31.19	8 03.7	2 07.3	11 56.88
Thur. 26	23 21 48.3	4.96	15 45.55	69	2 43.82	7 59.7	2 03.4	11 56.81
Fri. 27	23 19 37.0	5.98	15 45.51	69	2 56.32	7 55.8	1 59.5	11 56.73
Sat. 28	23 17 01.1	7.01	15 45.48	69	3 08.68	7 51.9	1 55.6	11 56.63
Sun. 29	23 14 00.7	8.03	15 45.44	69	3 20.86	7 48.0	1 51.7	11 56.52
Mon. 30	23 10 35.8	9.04	15 45.41	69	3 32.86	7 44.1	1 47.8	11 56.40
Tues. 31	N23 06 46.6	−10.06	15 45.39	69	3 44.64	7 40.2 A.M.	E.E. 1 43.9 A.M.	11 56.30

The sign + prefixed to the hourly change of declination indicates that { north / south } declinations are { increasing. / decreasing.

The sign − prefixed to the hourly change of declination indicates that { south / north } declinations are { increasing. / decreasing.

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Date	AT GREENWICH APPARENT NOON: THE SUN'S Apparent Declination	Diff. for 1 Hour	Semi-diameter	Time Semi-diameter Passing Mer.	Equation of Time, Add to Apparent Time	POLARIS FOR THE MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME: Upper Culmination	Elongation Lat. 40°	Declination +89°
	° ′ ″	″	′ ″	s	m s	h m	h m	′ ″
JULY, 1986								
Tues. 1	N23 06 46.6	−10.06	15 45.39	69	3 44.64	7 40.2 A.M.	E.E. 1 43.9 A.M.	11 56.30
Wed. 2	23 02 33.0	11.07	15 45.37	69	3 56.18	7 36.3	1 40.0	11 56.21
Thur. 3	22 57 55.3	12.07	15 45.36	69	4 07.46	7 32.4	1 36.1	11 56.13
Fri. 4	22 52 53.5	13.07	15 45.35	69	4 18.45	7 28.5	1 32.2	11 56.08
Sat. 5	22 47 27.7	14.07	15 45.35	69	4 29.13	7 24.6	1 28.3	11 56.05
Sun. 6	22 41 38.2	15.06	15 45.35	69	4 39.48	7 20.7	1 24.4	11 56.03
Mon. 7	22 35 25.0	16.04	15 45.36	68	4 49.47	7 16.8	1 20.4	11 56.03
Tues. 8	22 28 48.3	17.02	15 45.38	68	4 59.09	7 12.9	1 16.5	11 56.04
Wed. 9	22 21 48.2	17.98	15 45.40	68	5 08.30	7 09.0	1 12.6	11 56.05
Thur. 10	22 14 25.0	18.95	15 45.42	68	5 17.09	7 05.1	1 08.7	11 56.06
Fri. 11	22 06 38.8	19.90	15 45.45	68	5 25.44	7 01.2	1 04.8	11 56.06
Sat. 12	21 58 29.8	20.85	15 45.49	68	5 33.33	6 57.2	1 00.9	11 56.04
Sun. 13	21 49 58.2	21.78	15 45.[illegible]	68	5 40.75	6 53.3	0 57.0	11 56.02
Mon. 14	21 41 04.2	22.71	15 45.[illegible]	68	5 47.66	6 49.4	0 53.1	11 55.99
Tues. 15	21 31 48.0	23.63	15 45.63	68	5 54.07	6 45.5	0 49.2	11 55.96
Wed. 16	21 22 09.9	24.54	15 45.68	68	5 59.95	6 41.6	0 45.3	11 55.94
Thur. 17	21 12 10.0	25.44	15 45.74	68	6 05.30	6 37.7	0 41.4	11 55.94
Fri. 18	21 01 48.7	26.33	15 45.80	68	6 10.10	6 33.8	0 37.5	11 55.98
Sat. 19	20 51 06.1	27.21	15 45.87	68	6 14.35	6 29.9	0 33.6	11 56.04
Sun. 20	20 40 02.5	28.08	15 45.94	68	6 18.04	6 26.0	0 29.7	11 56.13
Mon. 21	20 28 38.1	28.94	15 46.01	68	6 21.17	6 22.1	0 25.8	11 56.24
Tues. 22	20 16 53.2	29.79	15 46.08	67	6 23.74	6 18.2	0 21.9	11 56.34
Wed. 23	20 04 48.0	30.64	15 46.16	67	6 25.73	6 14.3	0 18.0	11 56.43
Thur. 24	19 52 22.7	31.47	15 46.24	67	6 27.16	6 10.4	0 14.1	11 56.50
Fri. 25	19 39 37.6	32.29	15 46.32	67	6 28.02	6 06.5	0 10.1	11 56.55
Sat. 26	19 26 32.7	33.10	15 46.41	67	6 28.30	6 02.6	0 06.2	11 56.58
Sun. 27	19 13 08.6	33.91	15 46.50	67	6 28.00	5 58.7	{ 0 02.3 A.M. 11 58.4 P.M. }	11 56.62
Mon. 28	18 59 25.3	34.70	15 46.59	67	6 27.12	5 54.8	11 54.5	11 56.65
Tues. 29	18 45 23.1	35.48	15 46.69	67	6 25.66	5 50.9	11 50.6	11 56.70
Wed. 30	18 31 02.4	36.24	15 46.80	67	6 23.61	5 47.0	11 46.7	11 56.76
Thur. 31	N18 16 23.3	−37.00	15 46.90	67	6 20.97	5 43.1 A.M.	E.E. 11 42.8 P.M.	11 56.84
AUGUST, 1986								
Fri. 1	N18 01 26.3	−37.75	15 47.02	67	6 17.73	5 39.2 A.M.	E.E. 11 38.9 P.M.	11 56.95
Sat. 2	17 46 11.6	38.48	15 47.13	66	6 13.91	5 35.3	11 35.0	11 57.07
Sun. 3	17 30 39.4	39.20	15 47.25	66	6 09.48	5 31.4	11 31.1	11 57.21
Mon. 4	17 14 50.2	39.90	15 47.38	66	6 04.46	5 27.4	11 27.2	11 57.36
Tues. 5	16 58 44.1	40.60	15 47.51	66	5 58.84	5 23.5	11 23.3	11 57.51
Wed. 6	16 42 21.5	41.28	15 47.65	66	5 52.61	5 19.6	11 19.4	11 57.67
Thur. 7	16 25 42.8	41.94	15 47.79	66	5 45.79	5 15.7	11 15.5	11 57.81
Fri. 8	16 08 48.2	42.60	15 47.94	66	5 38.37	5 11.8	11 11.5	11 57.94
Sat. 9	15 51 38.1	43.24	15 48.09	66	5 30.36	5 07.9	11 07.6	11 58.06
Sun. 10	15 34 12.7	43.87	15 48.25	66	5 21.75	5 04.0	11 03.7	11 58.17
Mon. 11	15 16 32.5	44.48	15 48.41	66	5 12.55	5 00.1	10 59.8	11 58.28
Tues. 12	14 58 37.7	45.08	15 48.57	66	5 02.77	4 56.2	10 55.9	11 58.40
Wed. 13	14 40 28.6	45.67	15 48.74	66	4 52.41	4 52.3	10 52.0	11 58.53
Thur. 14	14 22 05.7	46.24	15 48.92	65	4 41.48	4 48.4	10 48.1	11 58.69
Fri. 15	14 03 29.1	46.80	15 49.09	65	4 29.99	4 44.5	10 44.2	11 58.88
Sat. 16	N13 44 39.3	−47.35	15 49.27	65	4 17.95	4 40.6 A.M.	E.E. 10 40.3 P.M.	11 59.10

The sign − prefixed to the hourly change of declination indicates that { south / north } declinations are { increasing. / decreasing.

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Date	AT GREENWICH APPARENT NOON: THE SUN'S Apparent Declination	Diff. for 1 Hour	Semi-diameter	Time Semi-diameter Passing Mer.	Equation of Time, Add to / Subtract from Apparent Time	POLARIS FOR THE MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME: Upper Culmination	Elongation Lat. 40°	Declination
								+89°
	° ′ ″	″	′ ″	s	m s	h m	h m	′ ″
AUGUST, 1986								
Sat. 16	N13 44 39.3	−47.35	15 49.27	65	4 17.95	4 40.6 A.M.	E.E. 10 40.3 P.M.	11 59.10
Sun. 17	13 25 36.5	47.88	15 49.45	65	4 05.37	4 36.7	10 36.4	11 59.33
Mon. 18	13 06 21.1	48.40	15 49.64	65	3 52.28	4 32.8	10 32.5	11 59.57
Tues. 19	12 46 53.4	48.91	15 49.82	65	3 38.67	4 28.9	10 28.6	11 59.81
Wed. 20	12 27 13.6	49.41	15 50.01	65	3 24.58	4 25.0	10 24.7	12 00.02
Thur. 21	12 07 21.9	49.89	15 50.20	65	3 10.02	4 21.0	10 20.8	12 00.21
Fri. 22	11 47 18.8	50.36	15 50.39	65	2 55.01	4 17.1	10 16.9	12 00.39
Sat. 23	11 27 04.4	50.83	15 50.58	65	2 39.55	4 13.2	10 13.0	12 00.56
Sun. 24	11 06 39.1	51.28	15 50.78	65	2 23.67	4 09.3	10 09.0	12 00.72
Mon. 25	10 46 03.1	51.71	15 50.98	65	2 07.39	4 05.4	10 05.1	12 00.90
Tues. 26	10 25 16.9	52.14	15 51.18	65	1 50.71	4 01.5	10 01.2	12 01.08
Wed. 27	10 04 20.5	52.55	15 51.38	65	1 33.65	3 57.6	9 57.3	12 01.29
Thur. 28	9 43 14.5	52.95	15 51.59	65	1 16.23	3 53.7	9 53.4	12 01.51
Fri. 29	9 21 59.1	53.33	15 51.80	64	0 58.46	3 49.8	9 49.5	12 01.75
Sat. 30	9 00 34.7	53.70	15 52.01	64	0 40.36	3 45.9	9 45.6	12 02.02
Sun. 31	N 8 39 01.5	−54.06	15 52.23	64	0 21.94	3 42.0 A.M.	E.E. 9 41.7 P.M.	12 02.29
SEPTEMBER, 1986								
Mon. 1	N 8 17 20.0	−54.40	15 52.45	64	0 03.21	3 38.1 A.M.	E.E. 9 37.8 P.M.	12 02.57
Tues. 2	7 55 30.4	54.73	15 52.67	64	0 15.80	3 34.2	9 33.9	12 02.85
Wed. 3	7 33 33.0	55.04	15 52.90	64	0 35.10	3 30.2	9 30.0	12 03.12
Thur. 4	7 11 28.4	55.34	15 53.13	64	0 54.65	3 26.3	9 26.1	12 03.38
Fri. 5	6 49 16.7	55.63	15 53.36	64	1 14.45	3 22.4	9 22.2	12 03.63
Sat. 6	6 26 58.3	55.90	15 53.60	64	1 34.48	3 18.5	9 18.2	12 03.86
Sun. 7	6 04 33.6	56.15	15 53.84	64	1 54.74	3 14.6	9 14.3	12 04.09
Mon. 8	5 42 02.9	56.40	15 54.09	64	2 15.19	3 10.7	9 10.4	12 04.32
Tues. 9	5 19 26.6	56.62	15 54.34	64	2 35.84	3 06.8	9 06.5	12 04.57
Wed. 10	4 56 45.0	56.84	15 54.59	64	2 56.65	3 02.9	9 02.6	12 04.83
Thur. 11	4 33 58.5	57.03	15 54.84	64	3 17.62	2 59.0	8 58.7	12 05.13
Fri. 12	4 11 07.4	57.22	15 55.10	64	3 38.73	2 55.1	8 54.8	12 05.45
Sat. 13	3 48 12.0	57.39	15 55.36	64	3 59.95	2 51.2	8 50.9	12 05.79
Sun. 14	3 25 12.8	57.54	15 55.62	64	4 21.26	2 47.2	8 47.0	12 06.14
Mon. 15	3 02 09.9	57.69	15 55.87	64	4 42.65	2 43.3	8 43.1	12 06.48
Tues. 16	2 39 03.8	57.82	15 56.13	64	5 04.09	2 39.4	8 39.1	12 06.81
Wed. 17	2 15 54.6	57.94	15 56.39	64	5 25.54	2 35.5	8 35.2	12 07.12
Thur. 18	1 52 42.8	58.04	15 56.66	64	5 47.00	2 31.6	8 31.3	12 07.41
Fri. 19	1 29 28.5	58.14	15 56.92	64	6 08.44	2 27.7	8 27.4	12 07.68
Sat. 20	1 06 12.2	58.22	15 57.18	64	6 29.85	2 23.8	8 23.5	12 07.95
Sun. 21	0 42 54.0	58.29	15 57.44	64	6 51.14	2 19.8	8 19.6	12 08.22
Mon. 22	N 0 19 34.3	58.34	15 57.70	64	7 12.37	2 15.9	8 15.7	12 08.51
Tues. 23	S 0 03 46.5	58.39	15 57.96	64	7 33.47	2 12.0	8 11.7	12 08.80
Wed. 24	0 27 08.2	58.41	15 58.22	64	7 54.44	2 08.1	8 07.8	12 09.12
Thur. 25	0 50 30.5	58.43	15 58.49	64	8 15.26	2 04.2	8 03.9	12 09.45
Fri. 26	1 13 52.8	58.43	15 58.75	64	8 35.89	2 00.3	8 00.0	12 09.80
Sat. 27	1 37 15.1	58.41	15 59.02	64	8 56.32	1 56.4	7 56.1	12 10.16
Sun. 28	2 00 36.8	58.39	15 59.28	64	9 16.54	1 52.5	7 52.2	12 10.53
Mon. 29	2 23 57.6	58.34	15 59.55	64	9 36.51	1 48.5	7 48.3	12 10.90
Tues. 30	2 47 17.2	58.28	15 59.82	64	9 56.23	1 44.6	7 44.3	12 11.27
Wed. 31	S 3 10 35.1	−58.21	16 00.09	64	10 15.66	1 40.7 A.M.	E.E. 7 40.4 P.M.	12 11.62

The sign − prefixed to the hourly change of declination indicates that { south / north } declinations are { increasing. / decreasing.

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Date	AT GREENWICH APPARENT NOON: THE SUN'S Apparent Declination	Diff. for 1 Hour	Semi-diameter	Time Semi-diameter Passing Mer.	Equation of Time, Subtract from Apparent Time	POLARIS FOR THE MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME: Upper Culmination	Elongation Lat. 40°	Declination
								+89°
	° ′ ″	″	′ ″	s	m s	h m	h m	′ ″
OCTOBER, 1986								
Wed. 1	S 3 10 35.1	−58.21	16 00.09	64	10 15.66	1 40.7 A.M.	E.E. 7 40.4 P.M.	12 11.62
Thur. 2	3 33 51.1	58.12	16 00.36	64	10 34.81	1 36.8	7 36.5	12 11.96
Fri. 3	3 57 04.7	58.01	16 00.64	64	10 53.63	1 32.9	7 32.6	12 12.29
Sat. 4	4 20 15.6	57.89	16 00.91	64	11 12.13	1 28.9	7 28.7	12 12.60
Sun. 5	4 43 23.4	57.75	16 01.19	64	11 30.29	1 25.0	7 24.7	12 12.91
Mon. 6	5 06 27.6	57.60	16 01.47	65	11 48.08	1 21.1	7 20.8	12 13.23
Tues. 7	5 29 27.9	57.43	16 01.75	65	12 05.49	1 17.2	7 16.9	12 13.57
Wed. 8	5 52 24.0	57.24	16 02.03	65	12 22.51	1 13.3	7 13.0	12 13.93
Thur. 9	6 15 15.4	57.03	16 02.32	65	12 39.13	1 09.4	7 09.1	12 14.32
Fri. 10	6 38 01.7	56.82	16 02.60	65	12 55 31	1 05.4	7 05.2	12 14.73
Sat. 11	7 00 42.5	56.58	16 02.88	65	13 11.05	1 01.5	7 01.2	12 15.14
Sun. 12	7 23 17.5	56.33	16 03.16	65	13 26.33	0 57.6	6 57.3	12 15.56
Mon. 13	7 45 46.3	56.06	16 03.44	65	13 41.11	0 53.7	6 53.4	12 15.96
Tues. 14	8 08 08.6	55.78	16 03.72	65	13 55.39	0 49.8	6 49.5	12 16.34
Wed. 15	8 30 23.9	55.49	16 04.00	65	14 09.15	0 45.8	6 45.5	12 16.70
Thur. 16	8 52 32.0	55.18	16 04.28	65	14 22.35	0 41.9	6 41.6	12 17.04
Fri. 17	9 14 32.5	54.86	16 04.55	65	14 34.98	0 38.0	6 37.7	12 17.37
Sat. 18	9 36 25.1	54.52	16 04.82	65	14 47.02	0 34.1	6 33.8	12 17.70
Sun. 19	9 58 09.4	54.16	16 05.10	66	14 58.44	0 30.1	6 29.8	12 18.03
Mon. 20	10 19 45.0	53.80	16 05.36	66	15 09.24	0 26.2	6 25.9	12 18.38
Tues. 21	10 41 11.6	53.41	16 05.63	66	15 19.38	0 22.3	6 22.0	12 18.74
Wed. 22	11 02 28.8	53.01	16 05.89	66	15 28.86	0 18.4	6 18.1	12 19.12
Thur. 23	11 23 36.2	52.60	16 06.16	66	15 37.65	0 14.5	6 14.2	12 19.51
Fri. 24	11 44 33.4	52.17	16 06.42	66	15 45.74	0 10.5	6 10.2	12 19.91
Sat. 25	12 05 20.1	51.72	16 06.67	66	15 53.11	0 06.6	6 06.3	12 20.33
Sun. 26	12 25 55.8	51.25	16 06.93	66	15 59.75	{ 0 02.7 A.M. 11 58.7 P.M. }	E.E. 6 02.4 P.M.	{ 12 20.74 12 21.15
Mon. 27	12 46 20.2	50.77	16 07.19	66	16 05.64	11 54.8	W.E. 5 55.1 A.M.	2 2.55
Tues. 28	13 06 32.7	50.27	16 07.44	66	16 10.78	11 50.9	5 51.2	12 21.93
Wed. 29	13 26 33.1	49.75	16 07.70	67	16 15.14	11 46.9	5 47.2	12 22.30
Thur. 30	13 46 20.8	49.22	16 07.95	67	16 18.72	11 43.0	5 43.3	12 22.65
Fri. 31	S14 05 55.5	−48.67	16 08.20	67	16 21.50	11 39.1 P.M.	W.E. 5 39.4 A.M.	12 22.99
NOVEMBER, 1986								
Sat. 1	S14 25 16.8	−48.10	16 08.45	67	16 23.49	11 35.2 P.M.	W.E. 5 35.4 A.M.	12 23.33
Sun. 2	14 44 24.1	47.51	16 08.70	67	16 24.68	11 31.2	5 31.5	12 23.68
Mon. 3	15 03 17.1	46.90	16 08.95	67	16 25.06	11 27.3	5 27.6	12 24.06
Tues. 4	15 21 55.4	46.28	16 09.20	67	16 24.63	11 23.4	5 23.7	12 24.46
Wed. 5	15 40 18.5	45.64	16 09.45	67	16 23.39	11 19.5	5 19.7	12 24.89
Thur. 6	15 58 25.9	44.98	16 09.70	67	16 21.33	11 15.5	5 15.8	12 25.32
Fri. 7	16 16 17.3	44.30	16 09.94	68	16 18.46	11 11.6	5 11.9	12 25.76
Sat. 8	16 33 52.2	43.60	16 10.19	68	16 14.78	11 07.7	5 08.0	12 26.18
Sun. 9	16 51 10.3	42.89	16 10.43	68	16 10.26	11 03.7	5 04.0	12 26.57
Mon. 10	17 08 11.1	42.16	16 10.67	68	16 04.93	10 59.8	5 00.1	12 26.95
Tues. 11	17 24 54.2	41.42	16 10.90	68	15 58.76	10 55.9	4 56.2	12 27.30
Wed. 12	17 41 19.2	40.66	16 11.13	68	15 51.75	10 51.9	4 52.2	12 27.64
Thur. 13	17 57 25.9	39.89	16 11.36	68	15 43.91	10 48.0	4 48.3	12 27.97
Fri. 14	18 13 13.7	39.10	16 11.59	68	15 35.24	10 44.0	4 44.3	12 28.30
Sat. 15	18 28 42.5	38.29	16 11.81	68	15 25.72	10 40.1	4 40.4	12 28.63
Sun. 16	S18 43 51.7	−37.47	16 12.02	69	15 15.36	10 36.2 P.M.	W.E. 4 36.5 A.M.	12 28.98

The sign − prefixed to the hourly change of declination indicates that { south / north } declinations are { increasing. / decreasing.

For time of Eastern Elongation of Polaris for any date after October 26th, subtract $5^h\ 56.4^m$ from the time of Upper Culmination of the same date.

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Date	AT GREENWICH APPARENT NOON: THE SUN'S Apparent Declination	Diff. for 1 Hour	Semi-diameter	Time Semi-diameter Passing Mer.	Equation of Time, Subtract from / Add to Apparent Time	POLARIS FOR THE MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME: Upper Culmination	Elongation Lat. 40°	Declination
								+89°
NOVEMBER, 1986								
Sun. 16	S18 43 51.7	−37.47	16 12.02	69	15 15.36	10 36.2 P.M.	W.E. 4 36.5 A.M.	12 28.98
Mon. 17	18 58 41.0	36.63	16 12.23	69	15 04.16	10 32.2	4 32.5	12 29.34
Tues. 18	19 13 10.1	35.78	16 12.44	69	14 52.12	10 28.3	4 28.6	12 29.72
Wed. 19	19 27 18.7	34.92	16 12.64	69	14 39.25	10 24.4	4 24.7	12 30.10
Thur. 20	19 41 06.2	34.04	16 12.84	69	14 25.55	10 20.4	4 20.7	12 30.49
Fri. 21	19 54 32.4	33.14	16 13.03	69	14 11.02	10 16.5	4 16.8	12 30.89
Sat. 22	20 07 37.0	32.23	16 13.22	69	13 55.68	10 12.6	4 12.9	12 31.28
Sun. 23	20 20 19.5	31.30	16 13.41	69	13 39.52	10 08.6	4 08.9	12 31.66
Mon. 24	20 32 39.6	30.36	16 13.59	70	13 22.57	10 04.7	4 05.0	12 32.02
Tues. 25	20 44 36.9	29.41	16 13.77	70	13 04.83	10 00.7	4 01.1	12 32.36
Wed. 26	20 56 11.1	28.44	16 13.94	70	12 46.31	9 56.8	3 57.1	12 32.69
Thur. 27	21 07 21.8	27.45	16 14.11	70	12 27.03	9 52.9	3 53.2	12 33.00
Fri. 28	21 18 08.7	26.45	16 14.28	70	12 07.01	9 48.9	3 49.2	12 33.30
Sat. 29	21 28 31.5	25.44	16 14.44	70	11 46.26	9 45.0	3 45.3	12 33.60
Sun. 30	S21 38 29.9	−24.42	16 14.61	70	11 24.81	9 41.0 P.M.	W.E. 3 41.3 A.M.	12 33.93
DECEMBER, 1986								
Mon. 1	S21 48 03.5	−23.38	16 14.76	70	11 02.69	9 37.1 P.M.	W.E. 3 37.4 A.M.	12 34.27
Tues. 2	21 57 12.0	22.33	16 14.92	70	10 39.91	9 33.2	3 33.5	12 34.64
Wed. 3	22 05 55.2	21.27	16 15.08	70	10 16.52	9 29.2	3 29.5	12 35.03
Thur. 4	22 14 12.7	20.19	16 15.23	70	9 52.53	9 25.3	3 25.6	12 35.42
Fri. 5	22 22 04.4	19.11	16 15.38	71	9 27.98	9 21.3	3 21.7	12 35.79
Sat. 6	22 29 29.8	18.01	16 15.52	71	9 02.90	9 17.4	3 17.7	12 36.14
Sun. 7	22 36 28.9	16.91	16 15.66	71	8 37.31	9 13.4	3 13.8	12 36.47
Mon. 8	22 43 01.3	15.79	16 15.80	71	8 11.24	9 09.5	3 09.8	12 36.76
Tues. 9	22 49 06.9	14.67	16 15.93	71	7 44.71	9 05.5	3 05.9	12 37.04
Wed. 10	22 54 45.5	13.54	16 16.06	71	7 17.76	9 01.6	3 01.9	12 37.30
Thur. 11	22 59 56.9	12.41	16 16.18	71	6 50.41	8 57.6	2 58.0	12 37.56
Fri. 12	23 04 41.0	11.26	16 16.30	71	6 22.69	8 53.7	2 54.0	12 37.81
Sat. 13	23 08 57.6	10.12	16 16.41	71	5 54.63	8 49.8	2 50.1	12 38.08
Sun. 14	23 12 46.7	8.97	16 16.52	71	5 26.26	8 45.8	2 46.1	12 38.36
Mon. 15	23 16 08.0	7.81	16 16.62	71	4 57.59	8 41.9	2 42.2	12 38.65
Tues. 16	23 19 01.5	6.65	16 16.71	71	4 28.68	8 37.9	2 38.2	12 38.95
Wed. 17	23 21 27.0	5.48	16 16.80	71	3 59.53	8 34.0	2 34.3	12 39.25
Thur. 18	23 23 24.6	4.31	16 16.88	71	3 30.19	8 30.0	2 30.4	12 39.55
Fri. 19	23 24 54.1	3.14	16 16.96	71	3 00.68	8 26.1	2 26.4	12 39.85
Sat. 20	23 25 55.5	1.97	16 17.03	71	2 31.03	8 22.1	2 22.5	12 40.14
Sun. 21	23 26 28.7	− 0.79	16 17.09	71	2 01.28	8 18.2	2 18.5	12 40.41
Mon. 22	23 26 33.6	+ 0.38	16 17.15	71	1 31.45	8 14.2	2 14.5	12 40.66
Tues. 23	23 26 10.2	1.56	16 17.20	71	1 01.59	8 10.3	2 10.6	12 40.89
Wed. 24	23 25 18.6	2.74	16 17.25	71	0 31.71	8 06.3	2 06.6	12 41.10
Thur. 25	23 23 58.7	3.92	16 17.29	71	0 01.85	8 02.4	2 02.7	12 41.29
Fri. 26	23 22 10.5	5.10	16 17.33	71	0 27.94	7 58.4	1 58.7	12 41.48
Sat. 27	23 19 54.1	6.27	16 17.37	71	0 57.65	7 54.5	1 54.8	12 41.68
Sun. 28	23 17 09.5	7.44	16 17.40	71	1 27.23	7 50.5	1 50.8	12 41.90
Mon. 29	23 13 56.9	8.61	16 17.42	71	1 56.64	7 46.6	1 46.9	12 42.14
Tues. 30	23 10 16.2	9.78	16 17.44	71	2 25.85	7 42.6	1 42.9	12 42.40
Wed. 31	23 06 07.6	10.93	16 17.46	71	2 54.82	7 38.7	1 39.0	12 42.66
Thur. 32	S23 01 31.3	+12.09	16 17.48	71	3 23.50	7 34.7 P.M.	W.E. 1 35.0 A.M.	12 42.93

The sign + prefixed to the hourly change of declination indicates that { north / south } declinations are { increasing. / decreasing. }

The sign − prefixed to the hourly change of declination indicates that { south / north } declinations are { increasing. / decreasing. }

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SELECTED STARS

Serial Number this list	No. from Nautical Almanac	Constellation Name	North Declination			South Declination		
			R.A.	Decl.	Mag.	R.A.	Decl.	Mag.
			h m	°		h m	°	
1	1	α Andromedae (Alpheratz)	0 08	+29	2.2			
2 x X		β Hydri				0 25	−77	2.9
3	4	β Ceti (Diphda)				0 43	−18	2.2
4 E		α Ursae Minoris (Polaris)	2 15	+89	2.1			
5	6	α Arietis (Hamal)	2 06	+23	2.2			
6	10	α Tauri (Aldebaran)	4 35	+16	1.1			
7	11	β Orionis (Rigel)				5 14	− 8	0.3
8	12	α Aurigae (Capella)	5 16	+46	0.2			
9	16	α Orionis (Betelgeuse)	5 54	+ 7	0.5 v			
10 x	17	α Carinae (Canopus)				6 24	−53	−0.9
11	18	α Canis Majoris (Sirius)				6 45	−17	−1.6
12	20	α Canis Minoris (Procyon)	7 39	+ 5	0.5			
13	21	β Geminorum (Pollux)	7 44	+28	1.2			
14	25	α Hydrae (Alphard)				9 27	− 9	2.2
15	26	α Leonis (Regulus)	10 08	+12	1.3			
16	28	β Leonis (Denebola)	11 48	+15	2.2			
17	33	α Virginis (Spica)				13 24	−11	1.2
18 x	36	θ Centauri (Menkent)				14 06	−36	2.3
19	37	α Bootis (Arcturus)	14 15	+19	0.2			
20	41	α Coronae Borealis (Alphecca)	15 34	+27	2.3			
21 x	42	α Scorpii (Antares)				16 29	−26	1.2
22	46	α Ophiuchi (Rasalhague)	17 34	+13	2.1			
23	49	α Lyrae (Vega)	18 36	+39	0.1			
24 x	50	σ Sagittarii (Nunki)				18 54	−26	2.1
25	51	α Aquilae (Altair)	19 50	+ 9	0.9			
26	54	ε Pegasi (Enif)	21 43	+10	2.5			
27 x	56	α Piscis Australis (Fomalhaut)				22 57	−30	1.3
28	57	α Pegasi (Markab)	23 04	+15	2.6			

x: Required for stations south of 30° north latitude.
X: South circumpolar; not included in principal list of stars, Nautical Almanac.
E: Tabulated in this Ephemeris for daily position, including elongation.
v: Varies from 0.1 to 1.2 in magnitude or brilliancy.

α: Alpha. β: Beta. ε: Epsilon. θ: Theta. σ: Sigma. These designations are in the order of brightness, each within its own constellation.

The planets and the bright stars Capella, Canopus, and Vega, are tabulated as an aid in finding stellar positions.

For the south circumpolar star, No. 2 β Hydri, the horizontal angles, and the hour angle at elongation, may be found by the following equations (the lat. and decl. being treated as positive):

At elongation: $\cos t = \cot\delta \tan\phi$; and, $\sin A = \frac{\cos\delta}{\cos\phi}$

At any hour angle: $$\tan A = \frac{\sin t}{\cos\phi \tan\delta - \sin\phi \cos t}$$

The product, $\sin\phi \cos t$, is subtracted for hour angles 0° to 90°; added for hour angles 90° to 180°. The hour angle, t, in these equations is in sidereal rate; conversions page 27.

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STAR TABLES, MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME

No.	Mag.	Transit Jan. 1	Decl. Jan. 1	Transit Jan. 16	Decl. Jan. 16	Transit Feb. 1	Decl. Feb. 1	Transit Feb. 16	Decl. Feb. 16	Transit Subtract for day of month	
		h m	° ′	h m	′	h m	′	h m	′		m
1– 1	2.2	5 23.4 PM	+29 00.9	4 24.4 PM	00.9	3 21.5 PM	00.8	2 22.5 PM	00.8	1	0.0
2	2.9	5 40.7	−77 20.4	4 41.7	20.3	3 38.8	20.3	2 39.8	20.2	2	3.9
3– 4	2.2	5 58.5	−18 04.0	4 59.5	04.0	3 56.6	04.0	2 57.6	04.0	3	7.9
4	2.1	7 32.8	+89 12.4	6 33.5	12.4	5 30.1	12.4	4 30.8	12.4	4	11.8
5– 6	2.2	7 21.8	+23 23.9	6 22.8	23.9	5 19.9	23.9	4 20.9	23.9	5	15.7
6–10	1.1	9 50.1	+16 29.0	8 51.1	29.0	7 48.2	29.0	6 49.3	29.0	6	19.7
7–11	0.3	10 28.8	− 8 13.0	9 29.8	13.0	8 26.9	13.0	7 27.9	13.1	7	23.6
8–12	0.2	10 30.6	+45 59.3	9 31.6	59.3	8 28.7	59.3	7 29.7	59.4	8	27.5
9–16	0.5v	11 09.2	+ 7 24.4	10 10.2	24.4	9 07.3	24.4	8 08.3	24.4	9	31.5
10–17	−0.9	11 38.4 PM	−52 41.2	10 39.4	41.3	9 36.5	41.3	8 37.5	41.4	10	35.4
11–18	−1.6	{ 0 03.1 AM 11 59.2 PM }	−16 41.7	11 00.2	41.7	9 57.3	41.8	8 58.3	41.8	11	39.3
12–20	0.5	0 57.0 AM	+ 5 15.8	11 54.1 PM	15.8	10 51.2	15.7	9 52.2	15.7	12	43.2
Jan. 15		{ 0 02.0 AM 11 58.0 PM }								13	47.2
13–21	1.2	1 02.9 AM	+28 03.7	{ 0 03.9 AM 11 60.0 PM }	03.7	10 57.1 PM	03.7	9 58.1	03.7	14	51.1
14–25	2.2	2 45.1	− 8 35.7	1 46.1 AM	35.8	0 43.2 AM	35.8	11 40.3 PM	35.9	15	55.0
Feb. 11						{ 0 03.8 AM 11 59.9 PM }				16	0.0
15–26	1.3	3 25.7	+12 02.2	2 26.7	02.2	1 23.8 AM	02.1	0 24.8 AM	02.1	17	3.9
Feb. 22								{ 0 01.2 AM 11 57.3 PM }		18	7.9
16–28	2.2	5 06.1	+14 39.0	4 07.1	38.9	3 04.2	38.9	2 05.3 AM	38.9	19	11.8
17–33	1.2	6 41.9 [2]	−11 05.3	5 43.0	05.3	4 40.1	05.4	3 41.1	05.4	20	15.7
18–36	2.3	7 23.2	−36 17.9	6 24.2	18.0	5 21.3	18.0	4 22.4	18.1	21	19.7
19–37	0.2	7 32.4	+19 15.2	6 33.4	15.1	5 30.5	15.0	4 31.5	15.0	22	23.6
20–41	2.3	8 51.2	+26 45.5	7 52.2	45.4	6 49.3	45.4	5 50.4	45.3	23	27.5
21–42	1.2	9 45.5 [4]	−26 24.1	8 46.5 [4]	24.1	7 43.6 [2 4]	24.2	6 44.7 [2 4]	24.2	24	31.5
22–46	2.1	10 51.1	+12 34.0	9 52.1	34.0	8 49.2	33.9	7 50.2	33.9	25	35.4
23–49	0.1	11 53.1 AM	+38 46.1	10 54.1	46.0	9 51.2	45.9	8 52.2	45.8	26	39.3
24–50	2.1	12 11.0 PM [1]	−26 19.1	11 12.0 AM [1]	19.1	10 09.1	19.0	9 10.1	19.0	27	43.2
25–51	0.9	1 06.5	+ 8 49.7	12 07.5 PM	49.7	11 04.6 AM	49.6	10 05.7	49.6	28	47.2
26–54	2.5	2 59.6	+ 9 48.5	2 00.6	48.5	12 57.7 PM	48.5	11 58.7 AM	48.4	29	51.1
27–56	1.3	4 12.8	−29 42.1	3 13.8	42.1	2 10.9	42.0	1 11.9 PM	42.0	30	55.0
28–57	2.6	4 19.9 PM	+13 07.8	3 21.0 PM	07.7	2 18.1 PM	07.7	1 19.1 PM	07.7	31	59.0
[1] Venus	−3.5	11 45 AM	−24 °	12 07 PM	−22 °	12 27 PM	−17 °	12 42 PM	−11 °		
[2] Mars	1.3	7 52 AM	−14	7 29 AM	−17	7 05 AM	−19	6 42 AM	−21		
[3] Jupiter	−1.5	2 40 PM	−16	1 55 PM	−15	1 06 PM	−14	12 21 PM	−13		
[4] Saturn	0.7	9 31 AM	−19	8 39 AM	−20	7 41 AM	−20	6 46 AM	−20		

Footnotes indicate near proximity of a planet to a star in time of transit and declination.

For time of transit subsequent to a star's double transit and until the next tabulated date, subtract for the number of days counting from the second transit of that date. All other interpolations may be taken directly by reference to the day of the month.

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STAR TABLES, MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME

No.	Mag.	Transit	Decl.	Transit	Decl.	Transit	Decl.	Transit	Decl	Transit Subtract for day of month	
		Mar. 1		Mar. 16		Apr. 1		Apr. 16			
		h m	° ′	h m	′	h m	′	h m	′		m
1– 1	2.2	1 31.4 PM	+29 00.7	12 32.4 PM	00.7	11 29.5 AM	00.7	10 30.5 AM	00.7	1	0.0
2	2.9	1 48.7	−77 20.1	12 49.7	20.1	11 46.8 AM	19.9	10 47.8	19.8	2	3.9
3– 4	2.2	2 06.5	−18 04.0	1 07.6	03.9	12 04.6 PM	03.9	11 05.7 AM	03.8	3	7.9
4	2.1	3 39.4	+89 12.4	2 40.1	12.3	1 37.0	12.3	12 37.9 PM	12.2	4	11.8
5– 6	2.2	3 29.8	+23 23.9	2 30.8	23.8	1 27.9	23.8	12 28.9 [1]	23.8	5	15.7
6–10	1.1	5 58.1	+16 29.0	4 59.2	29.0	3 56.2	29.0	2 57.3	29.0	6	19.7
7–11	0.3	6 36.8	− 8 13.1	5 37.8	13.1	4 34.9	13.1	3 35.9	13.0	7	23.6
8–12	0.2	6 38.6	+45 59.4	5 39.6	59.4	4 36.7	59.3	3 37.7	59.3	8	27.5
9–16	0.5v	7 17.2	+ 7 24.4	6 18.2	24.4	5 15.3	24.4	4 16.4	24.4	9	31.5
10–17	−0.9	7 46.4	−52 41.4	6 47.4	41.5	5 44.5	41.5	4 45.5	41.4	10	35.4
11–18	−1.6	8 07.2	−16 41.8	7 08.2	41.9	6 05.3	41.9	5 06.3	41.9	11	39.3
12–20	0.5	9 01.1	+ 5 15.7	8 02.1	15.7	6 59.2	15.7	6 00.2	15.7	12	43.2
13–21	1.2	9 07.0	+28 03.8	8 08.0	03.8	7 05.1	03.8	6 06.1	03.8	13	47.2
14–25	2.2	10 49.1	− 8 35.9	9 50.2	35.9	8 47.3	36.0	7 48.3	36.0	14	51.1
15–26	1.3	11 29.8 PM	+12 02.1	10 30.8 PM	02.1	9 27.9	02.1	8 28.9	02.1	15	55.0
16–28	2.2	1 14.1 AM	+14 38.9	0 15.2 AM	38.9	11 08.3 PM	38.9	10 09.3	38.9	16	0.0
Mar. 19				{ 0 03.4 AM 11 59.4 PM }						17	3.9
17–33	1.2	2 50.0	−11 05.4	1 51.0 AM	05.5	0 48.1 AM	05.5	11 45.2 PM	05.5	18	7.9
Apr. 13						{ 0 00.9 AM 11 57.9 PM }				19	11.8
18–36	2.3	3 31.3	−36 18.1	2 32.3	18.2	1 29.4 AM	18.2	0 30.4 AM	18.3	20	15.7
Apr. 23								{ 0 02.9 AM 11 59.0 PM }		21	19.7
19–37	0.2	3 40.4	+19 15.0	2 41.4	15.0	1 38.5	15.0	0 39.6 AM	15.1	22	23.6
Apr. 26								{ 0 00.2 AM 11 56.3 PM }		23	27.5
20–41	2.3	4 59.3	+26 45.3	4 00.3	45.3	2 57.4	45.3	1 58.4 AM	45.4	24	31.5
21–42	1.2	5 53.6 [2] [4]	−26 24.2	4 54.6 [2] [4]	24.2	3 51.7 [4]	24.2	2 52.7 [4]	24.3	25	35.4
22–46	2.1	6 59.1	+12 33.8	6 00.1	33.8	4 57.2	33.8	3 58.3	33.9	26	39.3
23–49	0.1	8 01.1	+38 45.8	7 02.1	45.8	5 59.2	45.8	5 00.3	45.8	27	43.2
24–50	2.1	8 19.0	−26 19.0	7 20.0	19.0	6 17.1 [2]	19.0	5 18.2 [2]	19.0	28	47.2
25–51	0.9	9 14.5	+ 8 49.6	8 15.6	49.6	7 12.7	49.6	6 13.7	49.6	29	51.1
26–54	2.5	11 07.6 AM	+ 9 48.4	10 08.7	48.4	9 05.8	48.4	8 06.8	48.4	30	55.0
27–56	1.3	12 20.6 PM	−29 42.0	11 21.8	41.9	10 18.9	41.9	9 20.0	41.8	31	59.0
28–57	2.6	12 28.0 PM	+15 07.6	11 29.0 AM	07.6	10 26.1 AM	07.6	9 27.1 AM	07.6		

[1] Venus	−3.3	12 51 PM	− 5°	1 00 PM	+ 3°	1 10 PM	+11°	1 22 PM	+17°	
[2] Mars	0.3	6 23 AM	−22	5 59 AM	−23	5 32 AM	−24	5 03 AM	−24	
[3] Jupiter	−1.6	11 42 AM	−12	10 56 AM	−10	10 07 AM	− 9	9 20 AM	− 8	
[4] Saturn	0.5	5 57 AM	−20	4 59 AM	−20	3 56 AM	−20	2 55 AM	−20	

Footnotes indicate near proximity of a planet to a star in time of transit and declination.

For reduction of time of transit from the Greenwich mean time to the local mean time at the longitude of the station, see table of Sidereal Conversions, page 27.

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STAR TABLES, MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME

No.	Mag.	May 1 Transit	May 1 Decl.	May 16 Transit	May 16 Decl.	June 1 Transit	June 1 Decl.	June 16 Transit	June 16 Decl.	Transit Subtract for day of month	
		h m	° ′	h m	′	h m	′	h m	′		m
1– 1	2.2	9 31.6 AM	+29 00.7	8 32.6 AM	00.7	7 29.7 AM	00.7	6 30.7 AM	00.7	1	0.0
2	2.9	9 48.9	−77 19.8	8 49.9	19.7	7 47.0	19.6	6 48.1	19.5	2	3.9
3– 4	2.2	10 06.7	−18 03.8	9 07.7	03.7	8 04.8	03.6	7 05.9	03.6	3	7.9
4	2.1	11 39.0	+89 12.1	10 40.2	12.1	9 37.5	12.0	8 38.8	12.0	4	11.8
5– 6	2.2	11 30.0 AM	+23 23.8	10 31.0 AM	23.8	9 28.1	23.8	8 29.1	23.8	5	15.7
6–10	1.1	1 58.3 PM [1]	+16 29.0	12 59.3 PM [1]	29.0	11 56.4 AM	29.0	10 57.4	29.0	6	19.7
7–11	0.3	2 36.9	− 8 13.0	1 38.0	13.0	12 35.0 PM	12.9	11 36.1	12.9	7	23.6
8–12	0.2	2 38.7	+45 59.3	1 39.7	59.3	12 36.8	59.2	11 37.9 AM	59.2	8	27.5
9–16	0.5v	3 17.4	+ 7 24.4	2 18.4	24.4	1 15.5	24.4	12 16.5 PM	24.4	9	31.5
10–17	−0.9	3 46.5	−52 41.4	2 47.5	41.4	1 44.6	41.3	12 45.6	41.2	10	35.4
11–18	−1.6	4 07.4	−16 41.8	3 08.4	41.8	2 05.5	41.8	1 06.5	41.7	11	39.3
12–20	0.5	5 01.3	+ 5 15.7	4 02.3	15.7	2 59.4	15.7	2 00.4	15.8	12	43.2
13–21	1.2	5 07.1	+28 03.8	4 08.2	03.8	3 05.2 [1]	03.8	2 06.3 [1]	03.8	13	47.2
14–25	2.2	6 49.3	− 8 36.0	5 50.3	35.9	4 47.4	35.9	3 48.4	35.9	14	51.1
15–26	1.3	7 29.9	+12 02.1	6 30.9	02.2	5 28.0	02.2	4 29.0	02.2	15	55.0
16–28	2.2	9 10.4	+14 38.9	8 11.4	39.0	7 08.5	39.0	6 09.5	39.0	16	0.0
17–33	1.2	10 46.2	−11 05.5	9 47.2	05.5	8 44.3	05.5	7 45.4	05.5	17	3.9
18–36	2.3	11 27.5	−36 18.3	10 28.5	18.4	9 25.6	18.4	8 26.6	18.4	18	7.9
19–37	0.2	11 36.7 PM	+19 15.1	10 37.7 PM	15.1	9 34.8	15.2	8 35.8	15.2	19	11.8
20–41	2.3	0 59.5 AM	+26 45.4	{ 0 00.5 AM 11 56.5 PM } [4]	45.5	10 53.6	45.5	9 54.6	45.6	20	15.7
21–42	1.2	1 53.8 [4]	−26 24.3	0 54.8 AM	24.3	11 47.9 PM [4]	24.3	10 49.0 [4]	24.3	21	19.7
May 29				{ 0 03.7 AM 11 59.7 PM }						22	23.6
22–46	2.1	2 59.3	+12 33.9	2 00.3 AM	33.9	0 57.4 AM	34.0	11 54.5 PM	34.0	23	27.5
June 15						{ 0 02.4 AM 11 58.4 PM }				24	31.5
23–49	0.1	4 01.3	+38 45.8	3 02.3	45.9	1 59.4 AM	46.0	1 00.5 AM	46.0	25	35.4
24–50	2.1	4 19.2 [2]	−26 19.0	3 20.2 [2]	19.0	2 17.3 [2]	19.0	1 18.4 [2]	19.0	26	39.3
25–51	0.9	5 14.7	+ 8 49.6	4 15.8	49.6	3 12.9	49.7	2 13.9	49.7	27	43.2
26–54	2.5	7 07.8	+ 9 48.4	6 08.8	48.5	5 05.9	48.5	4 07.0	48.6	28	47.2
27–56	1.3	8 21.0	−29 41.7	7 22.0	41.7	6 19.1	41.6	5 20.2	41.6	29	51.1
28–57	2.6	8 28.1 AM	+15 07.6	7 29.2 AM	07.7	6 26.3 AM	07.7	5 27.3 AM	07.8	30	55.0

[1] Venus	−3.4	1 38 PM	+22 °	1 58 PM	+25 °	2 19 PM	+25 °	2 36 PM	+22 °		
[2] Mars	−1.3	4 31 AM	−24	3 53 AM	−24	3 03 AM	−24	2 05 AM	−25		
[3] Jupiter	−1.9	8 32 AM	− 7	7 42 AM	− 6	6 48 AM	− 5	5 55 AM	− 4		
[4] Saturn	0.3	1 53 AM	−20	0 50 AM	−20	11 38 PM	−19	10 34 PM	−19		

Footnotes indicate near proximity of a planet to a star in time of transit and declination.

For time of transit subsequent to a star's double transit and until the next tabulated date, subtract for the number of days counting from the second transit of that date. All other interpolations may be taken directly by reference to the day of the month.

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STAR TABLES, MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME

No.	Mag.	July 1 Transit	July 1 Decl.	July 16 Transit	July 16 Decl.	Aug. 1 Transit	Aug. 1 Decl.	Aug. 16 Transit	Aug. 16 Decl.	Transit Subtract for day of month	
		h m	° ′	h m	′	h m	′	h m	′		m
1- 1	2.2	5 31.8 AM	+29 00.8	4 32.8 AM	00.8	3 29.9 AM	00.9	2 30.9 AM	01.0	1	0.0
2	2.9	5 49.1	−77 19.5	4 50.2	19.5	3 47.3	19.5	2 48.3	19.5	2	3.9
3- 4	2.2	6 06.9	−18 03.5	5 07.9	03.5	4 05.0	03.5	3 06.0	03.4	3	7.9
4	2.1	7 40.2	+89 11.9	6 41.6	11.9	5 39.1	11.9	4 40.6	12.0	4	11.8
5- 6	2.2	7 30.1	+23 23.9	6 31.2	23.9	5 28.3	23.9	4 29.3	24.0	5	15.7
6-10	1.1	9 58.5	+16 29.0	8 59.5	29.1	7 56.6	29.1	6 57.6	29.1	6	19.7
7-11	0.3	10 37.1	− 8 12.8	9 38.1	12.8	8 35.2	12.7	7 36.3	12.7	7	23.6
8-12	0.2	10 38.9	+45 59.2	9 39.9	59.2	8 37.0	59.1	7 38.0	59.1	8	27.5
9-16	0.5v	11 17.5	+ 7 24.5	10 18.6	24.5	9 15.7	24.5	8 16.7	24.5	9	31.5
10-17	−0.9	11 46.7 AM	−52 41.1	10 47.7	41.0	9 44.8	41.0	8 45.8	40.9	10	35.4
11-18	−1.6	12 07.5 PM	−16 41.7	11 08.5 AM	41.6	10 05.6	41.6	9 06.7	41.5	11	39.3
12-20	0.5	1 01.4	+ 5 15.8	12 02.4 PM	15.8	10 59.5	15.8	10 00.6	15.8	12	43.2
13-21	1.2	1 07.3	+28 03.8	12 08.3	03.8	11 05.4 AM	03.7	10 06.4	03.7	13	47.2
14-25	2.2	2 49.4	− 8 35.9	1 50.5	35.8	12 47.6 PM	35.8	11 48.6 AM	35.8	14	51.1
15-26	1.3	3 30.1 [1]	+12 02.2	2 31.1 [1]	02.2	1 28.2	02.2	12 29.2 PM	02.2	15	55.0
16-28	2.2	5 10.5	+14 39.0	4 11.5	39.0	3 08.6 [1]	39.0	2 09.7	39.0	16	0.0
17-33	1.2	6 46.4	−11 05.5	5 47.4	05.5	4 44.5	05.5	3 45.5 [1]	05.5	17	3.9
18-36	2.3	7 27.7	−36 18.4	6 28.7	18.4	5 25.8	18.4	4 26.8	18.4	18	7.9
19-37	0.2	7 36.8	+19 15.2	6 37.8	15.2	5 34.9	15.3	4 35.9	15.3	19	11.8
20-41	2.3	8 55.7	+26 45.6	7 56.7	45.7	6 53.8	45.7	5 54.8	45.7	20	15.7
21-42	1.2	9 50.0 [4]	−26 24.3	8 51.0 [4]	24.3	7 48.1 [4]	24.3	6 49.1 [4]	24.3	21	19.7
22-46	2.1	10 55.5 PM	+12 34.1	9 56.6	34.1	8 53.6	34.1	7 54.7	34.2	22	23.6
23-49	0.1	{0 01.5 AM, 11 57.5 PM} [2]	+38 46.1	10 58.6	46.2	9 55.7	46.3	8 56.7	46.3	23	27.5
24-50	2.1	0 19.4 AM	−26 19.0	11 16.5 PM [2]	19.0	10 13.6 [2]	19.0	9 14.6 [2]	19.0	24	31.5
July 5		{0 03.6 AM, 11 59.7 PM}								25	35.4
25-51	0.9	1 14.9 AM	+ 8 49.8	0 15.9 AM	49.8	11 09.1 PM	49.9	10 10.1 PM	49.9	26	39.3
July 20				{0 00.2 AM, 11 56.3 PM}						27	43.2
26-54	2.5	3 08.0	+ 9 48.6	2 09.0 AM	48.7	1 06.1 AM	48.7	0 07.2 AM	48.8	28	47.2
Aug. 17								{0 03.2 AM, 11 59.3 PM}		29	51.1
27-56	1.3	4 21.2	−29 41.6	3 22.2	41.5	2 19.3	41.5	1 20.3 AM	41.5	30	55.0
28-57	2.6	4 28.3 AM	+15 07.8	3 29.4 AM	07.9	2 26.5 AM	07.9	1 27.5 AM	08.0	31	59.0

[1] Venus	−3.8	2 48 PM	+17°	2 55 PM	+11°	2 56 PM	+ 3°	2 53 PM	− 5°
[2] Mars	−1.9	0 56 AM	−27	11 33 PM	−28	10 14 PM	−29	9 13 PM	−28
[3] Jupiter	−2.3	4 59 AM	− 4	4 01 AM	− 4	2 56 AM	− 4	1 53 AM	− 5
[4] Saturn	0.6	9 31 PM	−19	8 30 PM	−19	7 25 PM	−19	6 26 PM	−19

Footnotes indicate near proximity of a planet to a star in time of transit and declination.

For reduction of time of transit from the Greenwich mean time to the local mean time at the longitude of the station, see table of Sidereal Conversions, page 27.

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STAR TABLES, MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME

No.	Mag.	Sept. 1 Transit	Sept. 1 Decl.	Sept. 16 Transit	Sept. 16 Decl.	Oct. 1 Transit	Oct. 1 Decl.	Oct. 16 Transit	Oct. 16 Decl.	Transit Subtract for day of month	
		h m	° ′	h m	′	h m	′	h m	′		m
1– 1	2.2	1 28.0 AM	+29 01.0	0 29.0 AM { 0 01.5 AM 11 57.6 PM }	01.1	11 26.1 PM	01.1	10 27.1 PM	01.2	1	0.0
Sept. 23										2	3.9
2	2.9	1 45.4	−77 19.6	0 46.5 AM { 0 03.2 AM 11 59.3 PM }	19.7	11 43.6 PM	19.7	10 44.6	19.8	3	7.9
Sept. 27										4	11.8
3– 4	2.2	2 03.1	−18 03.4	1 04.2 AM	03.4	0 05.2 AM { 0 01.3 AM 11 57.3 PM }	03.4	11 02.3 PM	03.5	5	15.7
Oct. 2										6	19.7
4	2.1	3 38.1	+89 12.0	2 39.4	12.1	1 40.7 AM	12.2	0 41.9 AM { 0 02.6 AM 11 58.7 PM }	12.3	7	23.6
Oct. 26										8	27.5
5– 6	2.2	3 26.4	+23 24.0	2 27.4	24.1	1 28.5	24.1	0 29.5 AM { 0 02.0 AM 11 58.0 PM }	24.2	9	31.5
Oct. 23										10	35.4
6–10	1.1	5 54.7	+16 29.1	4 55.7	29.2	3 56.8	29.2	2 57.8 AM	29.2	11	39.3
7–11	0.3	6 33.4	− 8 12.7	5 34.4	12.7	4 35.4	12.7	3 36.4	12.7	12	43.2
8–12	0.2	6 35.1	+45 59.1	5 36.2	59.1	4 37.2	59.2	3 38.2	59.2	13	47.2
9–16	0.5v	7 13.8	+ 7 24.6	6 14.8	24.6	5 15.9	24.6	4 16.9	24.6	14	51.1
10–17	−0.9	7 42.9	−52 40.8	6 43.9	40.8	5 45.0	40.8	4 46.0	40.8	15	55.0
11–18	−1.6	8 03.8	−16 41.5	7 04.8	41.5	6 05.8	41.5	5 06.9	41.5	16	0.0
12–20	0.5	8 57.7	+ 5 15.8	7 58.7	15.8	6 59.7	15.8	6 00.7	15.8	17	3.9
13–21	1.2	9 03.5	+28 03.7	8 04.6	03.7	7 05.6	03.7	6 06.6	03.6	18	7.9
14–25	2.2	10 45.7	− 8 35.8	9 46.7	35.8	8 47.7	35.8	7 48.8	35.8	19	11.8
15–26	1.3	11 26.3 AM	+12 02.2	10 27.3 AM	02.2	9 28.4	02.1	8 29.4	02.1	20	15.7
16–28	2.2	1 06.7 PM	+14 39.0	12 07.8 PM	39.0	11 08.8 AM	38.9	10 09.8	38.9	21	19.7
17–33	1.2	2 42.6 [1]	−11 05.5	1 43.6 [1]	05.4	12 44.6 PM	05.4	11 45.7 AM	05.4	22	23.6
18–36	2.3	3 23.9	−36 18.4	2 24.9	18.4	1 25.9	18.3	12 26.9 PM [1]	18.3	23	27.5
19–37	0.2	3 33.0	+19 15.2	2 34.0	15.2	1 35.1	15.2	12 36.1	15.1	24	31.5
20–41	2.3	4 51.9	+26 45.7	3 52.9	45.7	2 53.9	45.7	1 54.9	45.6	25	35.4
21–42	1.2	5 46.2 [4]	−26 24.3	4 47.2 [4]	24.3	3 48.2 [4]	24.3	2 49.3 [4]	24.3	26	39.3
22–46	2.1	6 51.8	+12 34.2	5 52.8	34.2	4 53.8	34.2	3 54.8	34.2	27	43.2
23–49	0.1	7 53.8	+38 46.4	6 54.8	46.4	5 55.8	46.4	4 56.8	46.4	28	47.2
24–50	2.1	8 11.7 [2]	−26 19.0	7 12.7 [2]	19.0	6 13.7 [2]	19.0	5 14.7	19.0	29	51.1
25–51	0.9	9 07.2	+ 8 50.0	8 08.2	50.0	7 09.2	50.0	6 10.3	50.0	30	55.0
26–54	2.5	11 00.3 PM	+ 9 48.8	10 01.3	48.9	9 02.3	48.9	8 03.4	48.9	31	59.0
27–56	1.3	0 17.4 AM { 0 01.7 AM 11 57.8 PM }	−29 41.5	11 14.5	41.6	10 15.5	41.6	9 16.6	41.6		
Sept. 5											
28–57	2.6	0 24.6 AM { 0 01.0 AM 11 57.1 PM }	+15 08.0	11 21.7 PM	08.1	10 22.7 PM	08.1	9 23.7 PM	08.1		
Sept. 7											
[1] Venus	−4.1	2 46 PM	−12°	2 34 PM	−18°	2 10 PM	−23°	1 25 PM	−24°		
[2] Mars	−0.8	8 21 PM	−27	7 44 PM	−26	7 15 PM	−24	6 50 PM	−22		
[3] Jupiter	−2.4	0 43 AM	− 6	11 32 PM	− 7	10 26 PM	− 7	9 22 PM	− 8		
[4] Saturn	0.8	5 25 PM	−19	4 30 PM	−19	3 35 PM	−20	2 42 PM	−20		

Footnotes indicate near proximity of a planet to a star in time of transit and declination.

For time of transit subsequent to a star's double transit and until the next tabulated date, subtract for the number of days counting from the second transit of that date. All other interpolations may be taken directly by reference to the day of the month.

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STAR TABLES, MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME

No.	Mag.	Nov. 1 Transit	Nov. 1 Decl.	Nov. 16 Transit	Nov. 16 Decl.	Dec. 1 Transit	Dec. 1 Decl.	Dec. 16 Transit	Dec. 16 Decl.	Transit Subtract for day of month
		h m	° ′	h m	′	h m	′	h m	′	m
1– 1	2.2	9 24.2 PM	+29 01.2	8 25.3 PM	01.2	7 26.3 PM	01.3	6 27.3 PM	01.3	1 0.0
2	2.9	9 41.7	−77 19.9	8 42.7	20.0	7 43.7	20.0	6 44.7	20.0	2 3.9
3– 4	2.2	9 59.4	−18 03.5	9 00.4	03.5	8 01.4	03.6	7 02.4	03.6	3 7.9
4	2.1	11 35.2	+89 12.4	10 36.2	12.5	9 37.1	12.6	8 37.9	12.6	4 11.8
5– 6	2.2	11 22.6 PM	+23 24.2	10 23.7 PM	24.2	9 24.7	24.2	8 25.7	24.2	5 15.7
6–10	1.1	1 54.9 AM	+16 29.2	0 55.9 AM	29.2	11 53.0 PM	29.2	10 54.0	29.2	6 19.7
Nov. 30				{ 0 00.9 AM 11 57.0 PM }						7 23.6
7–11	0.3	2 33.5	− 8 12.7	1 34.6 AM	12.7	0 35.6 AM	12.8	11 32.7	12.8	8 27.5
Dec. 10						{ 0 00.2 AM 11 56.3 PM }				9 31.5
8–12	0.2	2 35.3	+45 59.2	1 36.4	59.2	0 37.4 AM	59.3	11 34.5 PM	59.3	10 35.4
Dec. 10						{ 0 02.0 AM 11 58.1 PM }				11 39.3
9–16	0.5v	3 14.0	+ 7 24.5	2 15.0	24.5	1 16.0 AM	24.5	0 17.1 AM	24.5	12 43.2
Dec. 28								{ 0 01.3 AM 11 57.4 PM }		13 47.2
10–17	−0.9	3 43.1	−52 40.9	2 44.1	40.9	1 45.2	41.0	0 46.2 AM	41.1	14 51.1
Dec. 27								{ 0 02.9 AM 11 59.0 PM }		15 55.0
11–18	−1.6	4 04.0	−16 41.5	3 05.0	41.6	2 06.0	41.6	1 07.0 AM	41.7	16 0.0
12–20	0.5	4 57.8	+ 5 15.8	3 58.9	15.8	2 59.9	15.7	2 00.9	15.7	17 3.9
13–21	1.2	5 03.7	+28 03.6	4 04.6	03.6	3 05.8	03.6	2 06.8	03.6	18 7.9
14–25	2.2	6 45.9	− 8 35.8	5 46.9	35.8	4 47.9	35.9	3 49.0	35.9	19 11.8
15–26	1.3	7 26.5	+12 02.1	6 27.5	02.0	5 28.5	02.0	4 29.6	01.9	20 15.7
16–28	2.2	9 06.9	+14 38.8	8 07.9	38.8	7 09.0	38.7	6 10.0	38.7	21 19.7
17–33	1.2	10 42.8	−11 05.5	9 43.8 [1]	05.5	8 44.8 [1]	05.5	7 45.8	05.6	22 23.6
18–36	2.3	11 24.0	−36 18.3	10 25.1	18.2	9 26.1	18.2	8 27.1	18.2	23 27.5
19–37	0.2	11 33.2 AM	+19 15.1	10 34.2	15.0	9 35.2	15.0	8 36.3	14.9	24 31.5
20–41	2.3	12 52.0 PM	+26 45.5	11 53.1 AM	45.5	10 54.1	45.4	9 55.1	45.3	25 35.4
21–42	1.2	1 46.3 [4]	−26 24.3	12 47.4 PM [4]	24.3	11 48.4 AM [4]	24.3	10 49.4 [4]	24.3	26 39.3
22–46	2.1	2 51.9	+12 34.1	1 52.9	34.1	12 53.9 PM	34.1	11 55.0 AM	34.0	27 43.2
23–49	0.1	3 53.9	+38 46.4	2 54.9	46.2	1 55.9	46.3	12 57.0 PM	46.2	28 47.2
24–50	2.1	4 11.8	−26 19.0	3 12.8	19.0	2 13.9	19.0	1 14.9	19.0	29 51.1
25–51	0.9	5 07.4	+ 8 50.0	4 08.4	50.0	3 09.4	49.9	2 10.4	49.9	30 55.0
26–54	2.5	7 00.5	+ 9 48.9	6 01.5	48.9	5 02.5	48.9	4 03.5	48.9	31 59.0
27–56	1.3	8 13.7	−29 41.7	7 14.7	41.7	6 15.7	41.7	5 16.7	41.7	
28–57	2.6	8 20.8 PM	+15 08.1	7 21.8 PM	08.1	6 22.8 PM	08.1	5 23.9 PM	08.1	

[1] Venus	−4.0	12 01 PM	−22°	10 34 AM	−16°	9 34 AM	−12°	9 03 AM	−13°	
[2] Mars	0.3	6 26 PM	−19	6 05 PM	−15	5 44 PM	−11	5 23 PM	− 7	
[3] Jupiter	−2.1	8 16 PM	− 8	7 18 PM	− 8	6 21 PM	− 8	5 28 PM	− 7	
[4] Saturn	0.7	1 45 PM	−20	12 53 PM	−20	12 02 PM	−21	11 10 AM	−21	

Footnotes indicate near proximity of a planet to a star in time of transit and declination.

For reduction of time of transit from the Greenwich mean time to the local mean time at the longitude of the station, see table of Sidereal Conversions, page 27.

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Mean Time Hour Angle	AZIMUTH OF POLARIS AT ALL HOUR ANGLES, 1986											CORR. TO AZIMUTH		
	Mean Declination + 89° 12′ 20″											Add for Decl. + 89°		
												12′10″	12′00″	11′50″
	Latitude											Subtract for Decl. + 89°		
	10°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	12′30″	12′40″	12′50″
h m	′	′	′	′	′	′	′	′	′	′	′	′	′	′
0 00.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0 10.0	2.1	2.1	2.2	2.2	2.2	2.2	2.3	2.3	2.3	2.4	2.4	0.0	0.0	0.0
19.9	4.2	4.3	4.3	4.3	4.4	4.4	4.5	4.6	4.7	4.7	4.8	0.0	0.0	0.0
29.9	6.3	6.4	6.4	6.5	6.6	6.7	6.7	6.9	7.0	7.1	7.2	0.0	0.0	0.1
0 39.9	8.4	8.5	8.6	8.6	8.7	8.9	9.0	9.1	9.3	9.4	9.6	0.0	0.1	0.1
49.9	10.5	10.6	10.7	10.8	10.9	11.0	11.2	11.4	11.6	11.8	12.0	0.0	0.1	0.1
59.8	12.6	12.6	12.8	12.9	13.0	13.2	13.4	13.6	13.8	14.1	14.4	0.0	0.1	0.1
1 09.8	14.6	14.7	14.8	15.0	15.1	15.3	15.5	15.8	16.1	16.3	16.7	0.1	0.1	0.2
19.8	16.6	16.7	16.9	17.0	17.2	17.4	17.7	18.0	18.3	18.6	19.0	0.1	0.1	0.2
29.8	18.6	18.7	18.9	19.0	19.3	19.5	19.8	20.1	20.4	20.8	21.2	0.1	0.1	0.2
1 39.7	20.5	20.7	20.8	21.0	21.3	21.5	21.8	22.2	22.6	23.0	23.4	0.1	0.2	0.2
49.7	22.4	22.6	22.8	23.0	23.2	23.5	23.9	24.2	24.6	25.1	25.6	0.1	0.2	0.2
59.7	24.3	24.4	24.6	24.9	25.2	25.5	25.8	26.2	26.7	27.2	27.7	0.1	0.2	0.3
2 09.6	26.1	26.2	26.5	26.7	27.0	27.4	27.8	28.2	28.7	29.2	29.8	0.1	0.2	0.3
19.6	27.8	28.0	28.3	28.5	28.9	29.2	29.6	30.1	30.6	31.2	31.8	0.1	0.2	0.3
29.6	29.5	29.7	30.0	30.3	30.6	31.0	31.4	31.9	32.5	33.1	33.7	0.1	0.2	0.3
2 39.6	31.2	31.4	31.7	32.0	32.3	32.7	33.2	33.7	34.3	34.9	35.6	0.1	0.2	0.3
49.5	32.8	33.0	33.3	33.6	34.0	34.4	34.9	35.4	36.0	36.7	37.4	0.1	0.2	0.4
59.5	34.3	34.5	34.8	35.2	35.6	36.0	36.5	37.1	37.7	38.4	39.1	0.1	0.3	0.4
3 09.5	35.7	36.0	36.3	36.7	37.1	37.5	38.0	38.6	39.3	40.0	40.8	0.1	0.3	0.4
19.5	37.1	37.4	37.7	38.1	38.5	39.0	39.5	40.1	40.8	41.6	42.4	0.1	0.3	0.4
29.4	38.5	38.7	39.1	39.4	39.9	40.4	40.9	41.6	42.2	43.0	43.9	0.1	0.3	0.4
3 39.4	39.7	40.0	40.3	40.7	41.2	41.7	42.2	42.9	43.6	44.4	45.3	0.1	0.3	0.4
49.4	40.9	41.2	41.5	41.9	42.4	42.9	43.5	44.2	44.9	45.7	46.6	0.1	0.3	0.4
59.3	42.0	42.3	42.6	43.0	43.5	44.0	44.6	45.3	46.1	46.9	47.9	0.2	0.3	0.5
4 09.3	43.0	43.3	43.6	44.1	44.5	45.1	45.7	46.4	47.2	48.0	49.0	0.2	0.3	0.5
19.3	43.9	44.2	44.6	45.0	45.5	46.1	46.7	47.4	48.2	49.1	50.1	0.2	0.3	0.5
29.3	44.8	45.1	45.4	45.9	46.4	47.0	47.6	48.3	49.1	50.0	51.0	0.2	0.3	0.5
4 39.2	45.5	45.8	46.2	46.7	47.2	47.7	48.4	49.1	50.0	50.9	51.9	0.2	0.3	0.5
49.2	46.2	46.5	46.9	47.3	47.9	48.5	49.1	49.9	50.7	51.6	52.6	0.2	0.3	0.5
59.2	46.8	47.1	47.5	47.9	48.5	49.1	49.7	50.5	51.3	52.2	53.3	0.2	0.3	0.5
5 09.2	47.3	47.6	48.0	48.5	49.0	49.6	50.3	51.0	51.9	52.8	53.8	0.2	0.3	0.5
19.1	47.7	48.0	48.4	48.9	49.4	50.0	50.7	51.4	52.3	53.2	54.3	0.2	0.3	0.5
29.1	48.0	48.3	48.7	49.2	49.7	50.3	51.0	51.8	52.6	53.6	54.6	0.2	0.4	0.5
5 39.1	48.2	48.6	49.0	49.4	49.9	50.6	51.2	52.0	52.9	53.8	54.9	0.2	0.4	0.5
49.0	48.4	48.7	49.1	49.5	50.1	50.7	51.4	52.1	53.0	54.0	55.0	0.2	0.4	0.5
57.2	...	...	...	...	...	...	...	...	...	...	55.0	0.2	0.4	0.6
5 57.3	...	...	...	...	...	...	...	...	...	54.0	...	0.2	0.4	0.6
57.5	...	...	...	...	...	...	...	...	53.0	...	...	0.2	0.4	0.6
57.6	...	...	...	...	...	...	...	52.2	...	...	...	0.2	0.4	0.5
5 57.7	...	...	...	...	...	...	51.4	...	...	...	...	0.2	0.4	0.5
57.9	...	...	...	...	...	50.7	...	...	...	...	...	0.2	0.4	0.5
58.0	...	...	...	...	50.1	...	...	...	...	...	...	0.2	0.4	0.5
5 58.1	...	...	...	49.6	...	...	...	...	...	...	...	0.2	0.3	0.5
58.2	...	...	49.1	...	...	...	...	...	...	...	...	0.2	0.3	0.5
58.3	...	48.7	...	...	...	...	...	...	...	...	...	0.2	0.3	0.5
5 58.5	48.4	...	...	...	...	...	...	...	...	...	...	0.2	0.3	0.5

See footnote pages 18 and 19 for equation to be employed when values in seconds are required.

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Mean Time Hour Angle	AZIMUTH OF POLARIS AT ALL HOUR ANGLES, 1986											CORR. TO AZIMUTH		
	Mean Declination + 89° 12′ 20″											Add for Decl. + 89°		
												12′10″	12′00″	11′50″
	Latitude											Subtract for Decl. + 89°		
	10°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	12′30″	12′48″	12′50″
h m	′	′	′	′	′	′	′	′	′	′	′	′	′	′
5 57.2	...	...	...	...	...	...	...	...	...	...	55.0	0.2	0.4	0.6
57.3	...	...	...	...	...	...	...	...	...	54.0	...	0.2	0.4	0.6
57.5	...	...	...	...	...	...	...	...	53.0	...	...	0.2	0.4	0.6
5 57.6	...	...	...	...	...	...	...	52.2	...	...	...	0.2	0.4	0.5
57.7	...	...	...	...	...	...	51.4	...	...	...	...	0.2	0.4	0.5
57.9	...	...	...	...	...	50.7	...	...	...	...	...	0.2	0.4	0.5
5 58.0	...	...	...	...	50.1	...	...	...	...	...	...	0.2	0.4	0.5
58.1	...	...	...	49.6	...	...	...	...	...	...	...	0.2	0.3	0.5
58.2	...	...	49.1	...	...	...	...	...	...	...	...	0.2	0.3	0.5
5 58.3	...	48.7	...	...	...	...	...	...	...	...	...	0.2	0.3	0.5
58.5	48.4	...	...	...	...	...	...	...	...	...	...	0.2	0.3	0.5
59.0	48.4	48.7	49.1	49.6	50.1	50.7	51.4	52.2	53.0	54.0	55.0	0.2	0.4	0.5
6 09.0	48.4	48.7	49.1	49.5	50.1	50.7	51.3	52.1	53.0	53.9	55.0	0.2	0.4	0.5
19.0	48.2	48.5	48.9	49.4	49.9	50.5	51.2	52.0	52.8	53.7	54.8	0.2	0.4	0.5
28.9	48.0	48.3	48.7	49.1	49.7	50.3	50.9	51.7	52.5	53.5	54.5	0.2	0.4	0.5
6 38.9	47.6	48.0	48.4	48.8	49.3	49.9	50.6	51.3	52.2	53.1	54.1	0.2	0.3	0.5
48.9	47.2	47.5	47.9	48.4	48.9	49.5	50.1	50.9	51.7	52.6	53.6	0.2	0.3	0.5
58.9	46.7	47.0	47.4	47.8	48.4	48.9	49.6	50.3	51.1	52.0	53.1	0.2	0.3	0.5
7 08.8	46.1	46.4	46.8	47.2	47.7	48.3	48.9	49.7	50.5	51.4	52.4	0.2	0.3	0.5
18.8	45.4	45.7	46.1	46.5	47.0	47.6	48.2	48.9	49.7	50.6	51.6	0.2	0.3	0.5
28.8	44.7	45.0	45.3	45.7	46.2	46.8	47.4	48.1	48.9	49.7	50.7	0.2	0.3	0.5
7 38.7	43.8	44.1	44.5	44.9	45.3	45.9	46.5	47.2	47.9	48.8	49.7	0.2	0.3	0.5
48.7	42.9	43.2	43.5	43.9	44.4	44.9	45.5	46.2	46.9	47.7	48.6	0.2	0.3	0.5
58.7	41.9	42.1	42.5	42.9	43.3	43.8	44.4	45.0	45.8	46.6	47.5	0.2	0.3	0.5
8 08.7	40.8	41.0	41.4	41.7	42.2	42.7	43.2	43.9	44.6	45.4	46.2	0.1	0.3	0.4
18.6	39.6	39.9	40.2	40.5	41.0	41.4	42.0	42.6	43.3	44.0	44.9	0.1	0.3	0.4
28.6	38.3	38.6	38.9	39.2	39.7	40.1	40.6	41.2	41.9	42.6	43.5	0.1	0.3	0.4
8 38.6	37.0	37.3	37.6	37.9	38.3	38.7	39.2	39.8	40.5	41.2	41.9	0.1	0.3	0.4
48.6	35.6	35.9	36.1	36.5	36.8	37.3	37.8	38.3	38.9	39.6	40.4	0.1	0.3	0.4
58.5	34.2	34.4	34.7	35.0	35.3	35.7	36.2	36.7	37.3	38.0	38.7	0.1	0.2	0.4
9 08.5	32.6	32.9	33.1	33.4	33.7	34.1	34.6	35.1	35.7	36.3	37.0	0.1	0.2	0.4
18.5	31.1	31.3	31.5	31.8	32.1	32.5	32.9	33.4	33.9	34.5	35.2	0.1	0.2	0.3
28.4	29.4	29.6	29.8	30.1	30.4	30.8	31.2	31.6	32.1	32.7	33.3	0.1	0.2	0.3
9 38.4	27.7	27.9	28.1	28.4	28.6	29.0	29.4	29.8	30.3	30.8	31.4	0.1	0.2	0.3
48.4	26.0	26.1	26.3	26.6	26.8	27.1	27.5	27.9	28.3	28.8	29.4	0.1	0.2	0.3
58.4	24.2	24.3	24.5	24.7	25.0	25.3	25.6	26.0	26.4	26.8	27.3	0.1	0.2	0.3
10 08.3	22.3	22.4	22.6	22.8	23.1	23.3	23.6	24.0	24.3	24.8	25.2	0.1	0.2	0.2
18.3	20.4	20.5	20.7	20.9	21.1	21.3	21.6	21.9	22.3	22.7	23.1	0.1	0.1	0.2
28.3	18.5	18.6	18.7	18.9	19.1	19.3	19.6	19.9	20.2	20.5	20.9	0.1	0.1	0.2
10 38.3	16.5	16.6	16.7	16.9	17.1	17.3	17.5	17.7	18.0	18.3	18.7	0.1	0.1	0.2
48.2	14.5	14.6	14.7	14.9	15.0	15.2	15.4	15.6	15.8	16.1	16.4	0.1	0.1	0.2
58.2	12.5	12.6	12.7	12.8	12.9	13.1	13.2	13.4	13.6	13.9	14.1	0.0	0.1	0.1
11 08.2	10.5	10.5	10.6	10.7	10.8	10.9	11.1	11.2	11.4	11.6	11.8	0.0	0.1	0.1
18.1	8.4	8.4	8.5	8.6	8.7	8.8	8.9	9.0	9.1	9.3	9.5	0.0	0.1	0.1
28.1	6.3	6.3	6.4	6.4	6.5	6.6	6.7	6.8	6.9	7.0	7.1	0.0	0.0	0.1
11 38.1	4.2	4.2	4.3	4.3	4.3	4.4	4.5	4.5	4.6	4.7	4.8	0.0	0.0	0.0
48.1	2.1	2.1	2.1	2.2	2.2	2.2	2.2	2.3	2.3	2.3	2.4	0.0	0.0	0.0
58.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

See footnote pages 18 and 19 for equation to be employed when values in seconds are required.

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Mean Time Hour Angle	AZIMUTH OF POLARIS AT ALL HOUR ANGLES, 1986											CORR. TO AZIMUTH		
	Mean Declination + 89° 12′ 20″											Add for Decl. + 89°		
												12′10″	12′00″	11′50″
	Latitude											Subtract for Decl. + 89°		
	30°	32°	34°	36°	38°	40°	42°	44°	46°	48°	50°	12′30″	12′40″	12′50″
h m	′	′	′	′	′	′	′	′	′	′	′	′	′	′
0 00.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0 10.0	2.4	2.5	2.5	2.6	2.7	2.7	2.8	2.9	3.0	3.2	3.3	0.0	0.0	0.0
19.9	4.8	4.9	5.1	5.2	5.3	5.5	5.7	5.9	6.1	6.3	6.6	0.0	0.0	0.1
29.9	7.2	7.4	7.6	7.8	8.0	8.2	8.5	8.8	9.1	9.4	9.8	0.0	0.1	0.1
0 39.9	9.6	9.8	10.1	10.3	10.6	10.9	11.3	11.7	12.1	12.6	13.1	0.0	0.1	0.1
49.9	12.0	12.3	12.6	12.9	13.2	13.6	14.1	14.5	15.1	15.7	16.3	0.0	0.1	0.1
59.8	14.4	14.7	15.0	15.4	15.8	16.3	16.8	17.4	18.0	18.7	19.5	0.1	0.1	0.2
1 09.8	16.7	17.0	17.4	17.9	18.4	18.9	19.5	20.2	20.9	21.7	22.7	0.1	0.1	0.2
19.8	19.0	19.4	19.8	20.3	20.9	21.5	22.2	23.0	23.8	24.7	25.8	0.1	0.2	0.2
29.8	21.2	21.7	22.2	22.8	23.4	24.1	24.8	25.7	26.6	27.7	28.8	0.1	0.2	0.3
1 39.7	23.4	23.9	24.5	25.1	25.8	26.6	27.4	28.3	29.4	30.5	31.8	0.1	0.2	0.3
49.7	25.6	26.2	26.8	27.5	28.2	29.0	30.0	31.0	32.1	33.4	34.8	0.1	0.2	0.3
59.7	27.7	28.3	29.0	29.7	30.5	31.4	32.4	33.5	34.7	36.1	37.6	0.1	0.2	0.3
2 09.6	29.8	30.4	31.1	31.9	32.8	33.8	34.8	36.0	37.3	38.8	40.4	0.1	0.2	0.4
19.6	31.8	32.5	33.2	34.1	35.0	36.0	37.2	38.4	39.8	41.4	43.1	0.1	0.3	0.4
29.6	33.7	34.5	35.3	36.2	37.1	38.2	39.4	40.8	42.3	43.9	45.7	0.1	0.3	0.4
2 39.6	35.6	36.4	37.2	38.2	39.2	40.4	41.6	43.0	44.6	46.3	48.3	0.1	0.3	0.4
49.5	37.4	38.2	39.1	40.1	41.2	42.4	43.7	45.2	46.9	48.7	50.7	0.1	0.3	0.4
59.5	39.1	40.0	40.9	42.0	43.1	44.4	45.8	47.3	49.0	50.9	53.1	0.2	0.3	0.5
3 09.5	40.8	41.7	42.7	43.7	44.9	46.2	47.7	49.3	51.1	53.1	55.3	0.2	0.3	0.5
19.5	42.4	43.3	44.3	45.4	46.7	48.0	49.5	51.2	53.1	55.1	57.4	0.2	0.3	0.5
29.4	43.9	44.8	45.9	47.0	48.3	49.7	51.3	53.0	54.9	57.0	59.4	0.2	0.3	0.5
3 39.4	45.3	46.3	47.4	48.5	49.9	51.3	52.9	54.7	56.7	58.9	61.3	0.2	0.4	0.5
49.4	46.6	47.6	48.7	50.0	51.3	52.8	54.5	56.3	58.3	60.6	63.1	0.2	0.4	0.6
59.3	47.9	48.9	50.0	51.3	52.7	54.2	55.9	57.8	59.9	62.2	64.8	0.2	0.4	0.6
4 09.3	49.0	50.1	51.2	52.5	53.9	55.5	57.2	59.1	61.3	63.6	66.3	0.2	0.4	0.6
19.3	50.1	51.1	52.3	53.6	55.1	56.7	58.4	60.4	62.6	65.0	67.7	0.2	0.4	0.6
29.3	51.0	52.1	53.3	54.6	56.1	57.7	59.5	61.5	63.7	66.2	68.9	0.2	0.4	0.6
4 39.2	51.9	53.0	54.2	55.6	57.1	58.7	60.5	62.6	64.8	67.3	70.1	0.2	0.4	0.6
49.2	52.6	53.7	55.0	56.4	57.9	59.6	61.4	63.4	65.7	68.3	71.1	0.2	0.4	0.6
59.2	53.3	54.4	55.7	57.1	58.6	60.3	62.2	64.2	66.5	69.1	71.9	0.2	0.4	0.6
5 09.2	53.8	55.0	56.2	57.6	59.2	60.9	62.8	64.9	67.2	69.8	72.7	0.2	0.4	0.6
19.1	54.3	55.4	56.7	58.1	59.7	61.4	63.3	65.4	67.7	70.3	73.2	0.2	0.4	0.6
29.1	54.6	55.8	57.1	58.5	60.1	61.8	63.7	65.8	68.2	70.8	73.7	0.2	0.4	0.6
5 39.1	54.9	56.0	57.3	58.7	60.3	62.0	64.0	66.1	68.4	71.1	74.0	0.2	0.4	0.7
49.0	55.0	56.2	57.5	58.9	60.5	62.2	64.1	66.2	68.6	71.2	74.1	0.2	0.4	0.7
55.2	...	...	...	...	...	...	...	...	...	...	74.2	0.3	0.5	0.8
5 55.5	...	...	...	...	...	...	...	...	...	71.2	...	0.2	0.5	0.7
55.7	...	...	...	...	...	...	...	...	68.6	...	...	0.2	0.5	0.7
56.0	...	...	...	...	...	...	...	66.3	...	...	...	0.2	0.5	0.7
5 56.2	...	...	...	...	...	...	64.1	...	...	...	...	0.2	0.4	0.7
56.4	...	...	...	...	...	62.2	...	...	...	...	...	0.2	0.4	0.7
56.5	...	...	...	...	60.5	...	...	...	...	...	...	0.2	0.4	0.6
5 56.7	...	...	...	58.9	...	...	...	...	...	...	...	0.2	0.4	0.6
56.9	...	...	57.5	...	...	...	...	...	...	...	...	0.2	0.4	0.6
57.0	...	56.2	...	...	...	...	...	...	...	...	...	0.2	0.4	0.6
5 57.2	55.0	...	...	...	...	...	...	...	...	...	...	0.2	0.4	0.6

Note: The equation shown on the opposite page may be employed when values in seconds are required, also for stations beyond the limits of the latitude tabulations, where:

A = Azimuth angle
t = Sidereal hour angle
ϕ = Latitude of station
δ = Declination of Polaris

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Mean Time Hour Angle	AZIMUTH OF POLARIS AT ALL HOUR ANGLES, 1986											CORR. TO AZIMUTH		
	Mean Declination + 89° 12′ 20″											Add for Decl. + 89°		
												12′10″	12′00″	11′50″
	Latitude											Subtract for Decl. + 89°		
	30°	32°	34°	36°	38°	40°	42°	44°	46°	48°	50°	12′30″	12′40″	12′50″
h m	′	′	′	′	′	′	′	′	′	′	′	′	′	′
5 55.2	...	...	...	...	...	...	...	...	...	...	74.2	0.3	0.5	0.8
55.5	...	...	...	...	...	...	...	...	...	71.2	...	0.2	0.5	0.7
55.7	...	...	...	...	...	...	...	...	68.6	...	...	0.2	0.5	0.7
5 56.0	...	...	...	...	...	...	...	66.3	...	...	...	0.2	0.5	0.7
56.2	...	...	...	...	...	...	64.1	...	...	...	...	0.2	0.4	0.7
56.4	...	...	...	...	...	62.2	...	...	...	...	...	0.2	0.4	0.7
5 56.5	...	...	...	...	60.5	...	...	...	...	...	...	0.2	0.4	0.6
56.7	...	...	...	58.9	...	...	...	...	...	...	...	0.2	0.4	0.6
56.9	...	...	57.5	...	...	...	...	...	...	...	...	0.2	0.4	0.6
5 57.0	...	56.2	...	...	...	...	...	...	...	...	...	0.2	0.4	0.6
57.2	55.0	...	...	...	...	...	...	...	...	...	...	0.2	0.4	0.6
59.0	55.0	56.2	57.5	58.9	60.5	62.2	64.1	66.3	68.6	71.2	74.1	0.2	0.4	0.7
6 09.0	55.0	56.1	57.4	58.8	60.4	62.1	64.0	66.2	68.5	71.1	74.0	0.2	0.4	0.7
19.0	54.8	56.0	57.2	58.6	60.2	61.9	63.8	65.9	68.3	70.9	73.8	0.2	0.4	0.6
28.9	54.5	55.7	56.9	58.3	59.9	61.6	63.5	65.6	67.9	70.5	73.4	0.2	0.4	0.6
6 38.9	54.1	55.3	56.5	57.9	59.5	61.2	63.0	65.1	67.4	70.0	72.8	0.2	0.4	0.6
48.9	53.6	54.8	56.0	57.4	58.9	60.6	62.4	64.5	66.8	69.3	72.1	0.2	0.4	0.6
58.9	53.1	54.2	55.4	56.8	58.3	59.9	61.8	63.8	66.0	68.5	71.3	0.2	0.4	0.6
7 08.8	52.4	53.5	54.7	56.0	57.5	59.1	60.9	62.9	65.2	67.6	70.4	0.2	0.4	0.6
18.8	51.6	52.7	53.9	55.2	56.6	58.2	60.0	62.0	64.2	66.6	69.3	0.2	0.4	0.6
28.8	50.7	51.8	52.9	54.2	55.7	57.2	59.0	60.9	63.0	65.4	68.1	0.2	0.4	0.6
7 38.7	49.7	50.8	51.9	53.2	54.6	56.1	57.8	59.7	61.8	64.1	66.7	0.2	0.4	0.6
48.7	48.6	49.7	50.8	52.0	53.4	54.9	56.6	58.4	60.5	62.7	65.3	0.2	0.4	0.6
58.7	47.5	48.5	49.6	50.8	52.1	53.6	55.2	57.0	59.0	61.2	63.7	0.2	0.4	0.6
8 08.7	46.2	47.2	48.2	49.4	50.7	52.2	53.7	55.5	57.4	59.6	62.0	0.2	0.4	0.5
18.6	44.9	45.8	46.8	48.0	49.2	50.6	52.2	53.9	55.7	57.8	60.2	0.2	0.4	0.5
28.6	43.5	44.4	45.4	46.5	47.7	49.0	50.5	52.1	54.0	56.0	58.2	0.2	0.3	0.5
8 38.6	41.9	42.8	43.8	44.8	46.0	47.3	48.7	50.3	52.1	54.0	56.2	0.2	0.3	0.5
48.6	40.4	41.2	42.1	43.1	44.3	45.5	46.9	48.4	50.1	52.0	54.1	0.2	0.3	0.5
58.5	38.7	39.5	40.4	41.4	42.4	43.6	45.0	46.4	48.0	49.8	51.8	0.2	0.3	0.5
9 08.5	37.0	37.7	38.6	39.5	40.5	41.7	42.9	44.3	45.9	47.6	49.5	0.1	0.3	0.4
18.5	35.2	35.9	36.7	37.6	38.6	39.6	40.8	42.2	43.6	45.3	47.1	0.1	0.3	0.4
28.4	33.3	34.0	34.7	35.6	36.5	37.5	38.7	39.9	41.3	42.8	44.6	0.1	0.3	0.4
9 38.4	31.4	32.0	32.7	33.5	34.4	35.4	36.4	37.6	38.9	40.4	42.0	0.1	0.2	0.4
48.4	29.4	30.0	30.7	31.4	32.2	33.1	34.1	35.2	36.4	37.8	39.3	0.1	0.2	0.3
58.4	27.3	27.9	28.5	29.2	30.0	30.8	31.7	32.8	33.9	35.2	36.6	0.1	0.2	0.3
10 08.3	25.2	25.8	26.3	27.0	27.7	28.4	29.3	30.2	31.3	32.5	33.7	0.1	0.2	0.3
18.3	23.1	23.6	24.1	24.7	25.3	26.0	26.8	27.7	28.6	29.7	30.9	0.1	0.2	0.3
28.3	20.9	21.3	21.8	22.3	22.9	23.6	24.3	25.0	25.9	26.9	28.0	0.1	0.2	0.2
10 38.3	18.7	19.1	19.5	20.0	20.5	21.1	21.7	22.4	23.2	24.0	25.0	0.1	0.1	0.2
48.2	16.4	16.8	17.1	17.5	18.0	18.5	19.1	19.7	20.4	21.1	22.0	0.1	0.1	0.2
58.2	14.1	14.4	14.7	15.1	15.5	15.9	16.4	16.9	17.5	18.2	18.9	0.1	0.1	0.2
11 08.2	11.8	12.1	12.3	12.6	13.0	13.3	13.7	14.2	14.6	15.2	15.8	0.0	0.1	0.1
18.1	9.5	9.7	9.9	10.1	10.4	10.7	11.0	11.4	11.8	12.2	12.7	0.0	0.1	0.1
28.1	7.1	7.3	7.4	7.6	7.8	8.0	8.3	8.5	8.8	9.2	9.5	0.0	0.1	0.1
11 38.1	4.8	4.9	5.0	5.1	5.2	5.4	5.5	5.7	5.9	6.1	6.4	0.0	0.0	0.1
48.1	2.4	2.4	2.5	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	0.0	0.0	0.0
58.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

$$\text{Tan } A = \frac{\sin t}{\cos\phi \tan\delta - \sin\phi \cos t}$$

The product, $\sin\phi \cos t$, is subtracted for hour angles 0° to 90° and added for hour angles from 90° to 180°.

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Mean Time Hour Angle	AZIMUTH OF POLARIS AT ALL HOUR ANGLES, 1986												CORR. TO AZIMUTH		
	Mean Declination + 89° 12′ 20″												Add for Decl. + 89°		
													12′10″	12′00″	11′50″
	Latitude												Subtract for Decl. + 89°		
	50°	52°	54°	56°	58°	60°	61°	62°	63°	64°	65°	Az.	12′30″	12′40″	12′50″
h m	′	′	′	′	′	′	′	′	′	′	′	°	′	′	′
0 00.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
0 10.0	3.3	3.4	3.6	3.8	4.0	4.3	4.4	4.5	4.7	4.9	5.1		0.0	0.0	0.0
19.9	6.6	6.9	7.2	7.6	8.0	8.5	8.8	9.1	9.4	9.8	10.1		0.0	0.1	0.1
29.9	9.8	10.3	10.8	11.4	12.0	12.7	13.2	13.6	14.1	14.6	15.2		0.0	0.1	0.1
0 39.9	13.1	13.7	14.4	15.1	16.0	17.0	17.5	18.1	18.7	19.4	20.2		0.1	0.1	0.2
49.9	16.3	17.1	17.9	18.8	19.9	21.1	21.8	22.6	23.3	24.2	25.1		0.1	0.1	0.2
59.8	19.5	20.4	21.4	22.5	23.8	25.3	26.1	27.0	27.9	28.9	30.1		0.1	0.2	0.2
1 09.8	22.7	23.7	24.8	26.1	27.6	29.3	30.3	31.3	32.4	33.6	34.9		0.1	0.2	0.3
19.8	25.8	26.9	28.2	29.7	31.4	33.4	34.4	35.6	36.9	38.2	39.7		0.1	0.2	0.3
29.8	28.8	30.1	31.6	33.3	35.1	37.3	38.5	39.8	41.2	42.7	44.4		0.1	0.2	0.4
1 39.7	31.8	33.3	34.9	36.7	38.8	41.2	42.5	43.9	45.5	47.2	49.0		0.1	0.3	0.4
49.7	34.8	36.3	38.1	40.1	42.4	45.0	46.4	48.0	49.7	51.5	53.5		0.1	0.3	0.4
59.7	37.6	39.3	41.2	43.4	45.9	48.7	50.2	51.9	53.8	55.7	57.9	0	0.2	0.3	0.5
2 09.6	40.4	42.2	44.3	46.6	49.3	52.3	54.0	55.8	57.7	59.9	2.2	1	0.2	0.3	0.5
19.6	43.1	45.1	47.3	49.7	52.5	55.8	57.6	59.5	1.6	3.9	6.3		0.2	0.4	0.6
29.6	45.7	47.8	50.1	52.8	55.7	59.2	1.1	3.1	5.3	7.7	10.3		0.2	0.4	0.6
2 39.6	48.3	50.5	52.9	55.7	58.8	2.4	4.4	6.6	8.9	11.4	14.2		0.2	0.4	0.6
49.5	50.7	53.0	55.6	58.5	1.8	5.6	7.7	9.9	12.4	15.0	17.9		0.2	0.4	0.6
59.5	53.1	55.4	58.1	1.2	4.6	8.6	10.8	13.1	15.7	18.5	21.5		0.2	0.5	0.7
3 09.5	55.3	57.8	0.6	3.7	7.3	11.4	13.7	16.2	18.9	21.7	24.8		0.2	0.5	0.7
19.5	57.4	60.0	2.9	6.2	9.9	14.2	16.5	19.1	21.9	24.8	28.1		0.2	0.5	0.7
29.4	59.4	2.1	5.1	8.5	12.3	16.7	19.2	21.8	24.7	27.8	31.1		0.3	0.5	0.8
3 39.4	1.3	4.1	7.2	10.7	14.6	19.2	21.7	24.4	27.4	30.5	34.0		0.3	0.5	0.8
49.4	3.1	5.9	9.1	12.7	16.8	21.4	24.0	26.8	29.9	33.1	36.7		0.3	0.5	0.8
59.3	4.8	7.6	10.9	14.6	18.8	23.6	26.2	29.1	32.2	35.5	39.1		0.3	0.6	0.8
4 09.3	6.3	9.2	12.6	16.3	20.6	25.5	28.2	31.1	34.3	37.7	41.4		0.3	0.6	0.8
19.3	7.7	10.7	14.1	17.9	22.3	27.3	30.0	33.0	36.2	39.7	43.5		0.3	0.6	0.9
29.3	8.9	12.0	15.5	19.4	23.8	28.9	31.7	34.7	38.0	41.5	45.4		0.3	0.6	0.9
4 39.2	10.1	13.2	16.7	20.7	25.2	30.3	33.2	36.2	39.6	43.2	47.0		0.3	0.6	0.9
49.2	11.1	14.2	17.8	21.8	26.4	31.6	34.5	37.6	40.9	44.6	48.5		0.3	0.6	0.9
59.2	11.9	15.1	18.7	22.8	27.4	32.6	35.6	38.7	42.1	45.8	49.8		0.3	0.6	0.9
5 09.2	12.7	15.9	19.5	23.6	28.2	33.5	36.5	39.7	43.1	46.8	50.8		0.3	0.6	0.9
19.1	13.2	16.5	20.1	24.2	28.9	34.3	37.2	40.4	43.9	47.6	51.6		0.3	0.6	0.9
29.1	13.7	16.9	20.6	24.7	29.4	34.8	37.8	41.0	44.4	48.2	52.2		0.3	0.6	0.9
5 39.1	14.0	17.2	20.9	25.1	29.8	35.2	38.1	41.4	44.8	48.6	52.6		0.3	0.6	0.9
49.0	14.1	17.4	21.1	25.2	29.9	35.3	38.3	41.5	45.0	48.7	52.8		0.3	0.6	0.9
52.2	...	...	...	...	...	...	...	...	...	...	52.8		0.4	0.8	1.2
5 52.5	...	...	...	...	...	...	...	...	...	48.8	...		0.4	0.8	1.1
52.8	...	...	...	...	...	...	...	...	45.0	...	...		0.4	0.7	1.1
53.1	...	...	...	...	...	...	...	41.5	...	...	...		0.4	0.7	1.1
5 53.3	...	...	...	...	...	...	38.3	...	...	...	...		0.3	0.7	1.0
53.5	...	...	...	...	...	35.3	...	...	...	...	...		0.3	0.7	1.0
53.9	...	...	...	...	30.0	...	...	...	...	...	...		0.3	0.6	0.9
5 54.3	...	...	...	25.2	...	...	...	...	...	...	...		0.3	0.6	0.9
54.7	...	...	21.1	...	...	...	...	...	...	...	...		0.3	0.6	0.9
55.0	...	17.4	...	...	...	...	...	...	...	...	...		0.3	0.5	0.8
5 55.2	14.2	...	...	...	...	...	...	...	...	...	...	1	0.3	0.5	0.8

See footnote pages 18 and 19 for equation to be employed when values in seconds are required.

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Mean Time Hour Angle	AZIMUTH OF POLARIS AT ALL HOUR ANGLES, 1986												CORR. TO AZIMUTH		
	Mean Declination + 89° 12′ 20″												Add for Decl. + 89°		
													12′10″	12′00″	11′50″
	Latitude												Subtract for Decl. + 89°		
	50°	52°	54°	56°	58°	60°	61°	62°	63°	64°	65°	Az.	12′30″	12′40″	12′50″
h m	′	′	′	′	′	′	′	′	′	′	′	°	′	′	′
5 52.2	...	...	...	...	...	...	...	...	...	...	52.8	1	0.4	0.8	1.2
52.5	...	...	...	...	...	...	...	...	...	48.8	...		0.4	0.8	1.1
52.8	...	...	...	...	...	...	...	...	45.0	...	...		0.4	0.7	1.1
5 53.1	...	...	...	...	...	...	...	41.5	...	...	...		0.4	0.7	1.1
53.3	...	...	...	...	...	...	38.3	...	...	...	...		0.3	0.7	1.0
53.5	...	...	...	...	...	35.3	...	...	...	...	...		0.3	0.7	1.0
5 53.9	...	...	...	...	30.0	...	...	...	...	...	...		0.3	0.6	0.9
54.3	...	...	...	25.2	...	...	...	...	...	...	...		0.3	0.6	0.9
54.7	...	...	21.1	...	...	...	...	...	...	...	...		0.3	0.6	0.9
5 55.0	...	17.4	...	...	...	...	...	...	...	...	...		0.3	0.5	0.8
55.2	14.2	...	...	...	...	...	...	...	...	...	...		0.3	0.5	0.8
59.0	14.1	17.4	21.1	25.2	29.9	35.3	38.3	41.5	45.0	48.7	52.8		0.3	0.6	0.9
6 09.0	14.0	17.3	20.9	25.1	29.8	35.1	38.1	41.3	44.7	48.5	52.5		0.3	0.6	0.9
19.0	13.8	17.0	20.6	24.8	29.4	34.8	37.7	40.9	44.3	48.0	52.0		0.3	0.6	0.9
28.9	13.4	16.6	20.2	24.3	28.9	34.2	37.1	40.3	43.7	47.4	51.4		0.3	0.6	0.9
6 38.9	12.8	16.0	19.6	23.6	28.2	33.5	36.4	39.5	42.9	46.5	50.5		0.3	0.6	0.9
48.9	12.1	15.3	18.8	22.8	27.4	32.6	35.5	38.5	41.9	45.5	49.4		0.3	0.6	0.9
58.9	11.3	14.4	17.9	21.9	26.4	31.5	34.3	37.4	40.7	44.2	48.1		0.3	0.6	0.9
7 08.8	10.4	13.4	16.9	20.8	25.2	30.3	33.1	36.1	39.3	42.8	46.6		0.3	0.6	0.9
18.8	9.3	12.3	15.7	19.5	23.9	28.8	31.6	34.5	37.7	41.2	44.9		0.3	0.6	0.9
28.8	8.1	11.0	14.4	18.1	22.4	27.3	30.0	32.9	36.0	39.4	43.0		0.3	0.6	0.9
7 38.7	6.7	9.6	12.9	16.6	20.8	25.5	28.2	31.0	34.1	37.4	40.9		0.3	0.6	0.8
48.7	5.3	8.1	11.3	14.9	19.0	23.6	26.2	29.0	32.0	35.2	38.7		0.3	0.6	0.8
58.7	3.7	6.5	9.6	13.1	17.0	21.6	24.1	26.8	29.7	32.8	36.2		0.3	0.5	0.8
8 08.7	2.0	4.7	7.7	11.1	15.0	19.4	21.8	24.4	27.3	30.3	33.6		0.3	0.5	0.8
18.6	0.2	2.8	5.7	9.0	12.8	17.0	19.4	21.9	24.7	27.6	30.8		0.3	0.5	0.8
28.6	58.2	0.8	3.6	6.8	10.4	14.5	16.8	19.3	21.9	24.8	27.9		0.2	0.5	0.7
8 38.6	56.2	58.6	1.4	4.4	7.9	11.9	14.1	16.5	19.0	21.8	24.8		0.2	0.5	0.7
48.6	54.1	56.4	59.0	2.0	5.3	9.2	11.3	13.6	16.0	18.6	21.5		0.2	0.5	0.7
58.5	51.8	54.1	56.6	59.4	2.6	6.3	8.3	10.5	12.8	15.4	18.1		0.2	0.4	0.7
9 08.5	49.5	51.6	54.0	56.7	59.8	3.3	5.2	7.3	9.5	11.9	14.6		0.2	0.4	0.6
18.5	47.1	49.1	51.4	53.9	56.9	0.2	2.0	4.0	6.1	8.4	10.9		0.2	0.4	0.6
28.4	44.6	46.5	48.6	51.1	53.8	56.9	58.7	0.6	2.6	4.7	7.1		0.2	0.4	0.6
9 38.4	42.0	43.8	45.8	48.1	50.7	53.6	55.3	57.0	58.9	0.9	3.2	1	0.2	0.4	0.5
48.4	39.3	41.0	42.9	45.0	47.4	50.2	51.7	53.4	55.1	57.1	59.1	0	0.2	0.3	0.5
58.4	36.6	38.1	39.9	41.9	44.1	46.7	48.1	49.6	51.3	53.1	55.0		0.2	0.3	0.5
10 08.3	33.7	35.2	36.8	38.7	40.7	43.1	44.4	45.8	47.3	49.0	50.7		0.1	0.3	0.4
18.3	30.9	32.2	33.7	35.4	37.3	39.4	40.6	41.9	43.3	44.8	46.4		0.1	0.3	0.4
28.3	28.0	29.2	30.5	32.0	33.7	35.7	36.8	37.9	39.2	40.5	42.0		0.1	0.2	0.4
10 38.3	25.0	26.0	27.2	28.6	30.1	31.9	32.9	33.9	35.0	36.2	37.5		0.1	0.2	0.3
48.2	22.0	22.9	24.0	25.1	26.5	28.0	28.9	29.8	30.8	31.8	33.0		0.1	0.2	0.3
58.2	18.9	19.7	20.6	21.6	22.8	24.1	24.8	25.6	26.5	27.4	28.4		0.1	0.2	0.2
11 08.2	15.8	16.5	17.2	18.1	19.1	20.2	20.8	21.4	22.1	22.9	23.7		0.1	0.1	0.2
18.1	12.7	13.2	13.8	14.5	15.3	16.2	16.7	17.2	17.8	18.4	19.0		0.1	0.1	0.2
28.1	9.5	9.9	10.4	10.9	11.5	12.2	12.5	12.9	13.3	13.8	14.3		0.0	0.1	0.1
11 38.1	6.4	6.6	6.9	7.3	7.7	8.1	8.4	8.6	8.9	9.2	9.5		0.0	0.1	0.1
48.1	3.2	3.3	3.5	3.6	3.8	4.1	4.2	4.3	4.5	4.6	4.8		0.0	0.0	0.0
58.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0

See footnote pages 18 and 19 for equation to be employed when values in seconds are required.

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Lat.	Correction to the Time of Elongation	AZIMUTH OF POLARIS AT ELONGATION, 1986						
		Decl. +89°						
		11′ 50″	12′ 00″	12′ 10″	12′ 20″	12′ 30″	12′ 40″	12′ 50″
° ′	W E	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″
10 00	+2.1−	0 48 55	0 48 44	0 48 34	0 48 24	0 48 14	0 48 04	0 47 54
12 00	2.0	0 49 15	0 49 04	0 48 54	0 48 44	0 48 34	0 48 23	0 48 13
14 00	1.9	0 49 38	0 49 28	0 49 18	0 49 08	0 48 57	0 48 47	0 48 37
16 00	1.8	0 50 06	0 49 56	0 49 46	0 49 35	0 49 25	0 49 14	0 49 04
18 00	1.6	0 50 39	0 50 28	0 50 18	0 50 07	0 49 57	0 49 46	0 49 36
20 00	1.5	0 51 15	0 51 05	0 50 54	0 50 44	0 50 33	0 50 22	0 50 12
21 00	1.5	0 51 36	0 51 25	0 51 14	0 51 03	0 50 53	0 50 42	0 50 31
22 00	1.4	0 51 57	0 51 46	0 51 35	0 51 25	0 51 14	0 51 03	0 50 52
23 00	1.3	0 52 20	0 52 09	0 51 58	0 51 47	0 51 36	0 51 25	0 51 14
24 00	1.3	0 52 44	0 52 33	0 52 22	0 52 11	0 52 00	0 51 49	0 51 38
25 00	1.2	0 53 09	0 52 58	0 52 47	0 52 36	0 52 25	0 52 14	0 52 03
26 00	1.1	0 53 35	0 53 24	0 53 13	0 53 02	0 52 51	0 52 40	0 52 29
27 00	1.1	0 54 04	0 53 52	0 53 41	0 53 30	0 53 19	0 53 07	0 52 56
28 00	1.0	0 54 33	0 54 22	0 54 11	0 53 59	0 53 48	0 53 37	0 53 25
29 00	0.9	0 55 04	0 54 53	0 54 41	0 54 30	0 54 19	0 54 07	0 53 56
30 00	0.8	0 55 37	0 55 26	0 55 14	0 55 02	0 54 51	0 54 39	0 54 28
31 00	0.8	0 56 12	0 56 00	0 55 48	0 55 37	0 55 25	0 55 13	0 55 02
32 00	0.7	0 56 48	0 56 36	0 56 24	0 56 12	0 56 01	0 55 49	0 55 37
33 00	0.6	0 57 26	0 57 14	0 57 02	0 56 50	0 56 38	0 56 26	0 56 14
34 00	0.5	0 58 06	0 57 54	0 57 42	0 57 30	0 57 18	0 57 06	0 56 54
35 00	0.4	0 58 48	0 58 36	0 58 24	0 58 11	0 57 59	0 57 47	0 57 35
36 00	0.4	0 59 32	0 59 20	0 59 08	0 58 55	0 58 43	0 58 30	0 58 18
37 00	0.3	1 00 19	1 00 06	0 59 54	0 59 41	0 59 29	0 59 16	0 59 04
38 00	0.2	1 01 08	1 00 55	1 00 42	1 00 29	1 00 17	1 00 04	0 59 51
39 00	+0.1−	1 01 59	1 01 46	1 01 33	1 01 20	1 01 07	1 00 54	1 00 42
40 00	0.0	1 02 53	1 02 40	1 02 27	1 02 14	1 02 00	1 01 47	1 01 34
41 00	−0.1+	1 03 49	1 03 36	1 03 23	1 03 10	1 02 56	1 02 43	1 02 30
42 00	0.2	1 04 49	1 04 36	1 04 22	1 04 09	1 03 55	1 03 42	1 03 28
43 00	0.3	1 05 52	1 05 38	1 05 24	1 05 11	1 04 57	1 04 43	1 04 30
44 00	0.4	1 06 58	1 06 44	1 06 30	1 06 16	1 06 02	1 05 48	1 05 34
45 00	0.5	1 08 07	1 07 53	1 07 39	1 07 25	1 07 11	1 06 56	1 06 42
46 00	0.6	1 09 20	1 09 06	1 08 52	1 08 37	1 08 23	1 08 08	1 07 54
47 00	0.7	1 10 38	1 10 23	1 10 08	1 09 54	1 09 39	1 09 24	1 09 10
48 00	0.9	1 11 59	1 11 44	1 11 29	1 11 14	1 10 59	1 10 44	1 10 30
49 00	1.0	1 13 25	1 13 10	1 12 55	1 12 40	1 12 24	1 12 09	1 11 54
50 00	1.1	1 14 56	1 14 41	1 14 25	1 14 10	1 13 54	1 13 38	1 13 23
51 00	1.3	1 16 32	1 16 17	1 16 01	1 15 45	1 15 29	1 15 13	1 14 57
52 00	1.4	1 18 14	1 17 58	1 17 42	1 17 26	1 17 09	1 16 53	1 16 37
53 00	1.6	1 20 02	1 19 46	1 19 29	1 19 13	1 18 56	1 18 39	1 18 23
54 00	1.7	1 21 57	1 21 40	1 21 23	1 21 06	1 20 49	1 20 32	1 20 15
55 00	1.9	1 23 59	1 23 41	1 23 24	1 23 07	1 22 49	1 22 32	1 22 14
55 30	2.0	1 25 03	1 24 45	1 24 27	1 24 10	1 23 52	1 23 34	1 23 17
56 00	2.1	1 26 09	1 25 51	1 25 33	1 25 15	1 24 57	1 24 39	1 24 21
56 30	2.1	1 27 16	1 26 58	1 26 40	1 26 22	1 26 04	1 25 46	1 25 28
57 00	2.2	1 28 27	1 28 08	1 27 50	1 27 32	1 27 13	1 26 55	1 26 36
57 30	2.3	1 29 39	1 29 21	1 29 02	1 28 43	1 28 25	1 28 06	1 27 47
58 00	2.4	1 30 54	1 30 35	1 30 16	1 29 57	1 29 39	1 29 20	1 29 01
58 30	2.5	1 32 12	1 31 52	1 31 33	1 31 14	1 30 55	1 30 36	1 30 17
59 00	2.6	1 33 32	1 33 12	1 32 53	1 32 33	1 32 14	1 31 55	1 31 35
59 30	2.7	1 34 55	1 34 35	1 34 15	1 33 56	1 33 36	1 33 16	1 32 56
60 00	2.8	1 36 21	1 36 01	1 35 41	1 35 21	1 35 01	1 34 41	1 34 21
60 30	3.0	1 37 50	1 37 29	1 37 09	1 36 49	1 36 28	1 36 08	1 35 48
61 00	3.1	1 39 22	1 39 01	1 38 40	1 38 20	1 37 59	1 37 39	1 37 18
61 30	3.2	1 40 57	1 40 36	1 40 15	1 39 54	1 39 33	1 39 13	1 38 52
62 00	3.3	1 42 37	1 42 15	1 41 54	1 41 33	1 41 11	1 40 50	1 40 29
62 30	3.4	1 44 20	1 43 58	1 43 36	1 43 15	1 42 53	1 42 31	1 42 10
63 00	3.6	1 46 07	1 45 45	1 45 23	1 45 00	1 44 38	1 44 16	1 43 54
63 30	3.7	1 47 58	1 47 35	1 47 13	1 46 51	1 46 28	1 46 06	1 45 43
64 00	3.9	1 49 53	1 49 31	1 49 08	1 48 45	1 48 22	1 47 59	1 47 37
64 30	4.0	1 51 54	1 51 31	1 51 07	1 50 44	1 50 21	1 49 58	1 49 34
65 00	4.2	1 53 59	1 53 36	1 53 12	1 52 48	1 52 25	1 52 01	1 51 37
65 30	4.3	1 56 10	1 55 46	1 55 22	1 54 58	1 54 34	1 54 09	1 53 45
66 00	4.5	1 58 27	1 58 02	1 57 37	1 57 13	1 56 48	1 56 24	1 55 59
66 30	4.7	2 00 49	2 00 24	1 59 59	1 59 34	1 59 09	1 58 43	1 58 18
67 00	4.8	2 03 18	2 02 52	2 02 27	2 02 01	2 01 35	2 01 10	2 00 44
67 30	5.0	2 05 53	2 05 27	2 05 01	2 04 35	2 04 09	2 03 43	2 03 16
68 00	5.2	2 08 36	2 08 10	2 07 43	2 07 16	2 06 49	2 06 23	2 05 56
68 30	5.4	2 11 27	2 11 00	2 10 32	2 10 05	2 09 38	2 09 11	2 08 43
69 00	5.6	2 14 26	2 13 58	2 13 30	2 13 02	2 12 34	2 12 07	2 11 39
69 30	5.9	2 17 34	2 17 06	2 16 37	2 16 08	2 15 40	2 15 11	2 14 43
70 00	−6.1+	2 20 52	2 20 23	2 19 53	2 19 24	2 18 55	2 18 26	2 17 56

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TO FIND THE LATITUDE BY AN ALTITUDE OBSERVATION OF POLARIS AT ANY HOUR ANGLE, 1986

Primary Adjustment to Elevation of Pole

Mean Time Hour Angle	Subtract Polaris Above the Pole				Add Polaris Below the Pole				Mean Time Hour Angle
	Decl. +89°				Decl. +89°				
	11′ 50″	12′ 10″	12′ 30″	12′ 50″	11′ 50″	12′ 10″	12′ 30″	12′ 50″	
h m	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	h m
0 00.0	0 48 10	0 47 50	0 47 30	0 47 10	0 00 00 0 00 20	0 00 00 0 00 20	0 00 00 0 00 20	0 00 00 0 00 19	5 57.4 5 59.0
0 12.0	0 48 06	0 47 46	0 47 26	0 47 06	0 01 36	0 01 35	0 01 34	0 01 33	6 05.0
23.9	47 54	47 34	47 14	46 54	02 51	02 50	02 49	02 47	11.0
35.9	47 34	47 14	46 54	46 35	04 07	04 05	04 03	04 01	17.0
47.9	47 [illegible]	46 46	46 27	46 07	05 22	05 20	05 17	05 15	23.0
59.8	46 30	46 11	45 52	45 32	06 37	06 34	06 31	06 28	28.9
1 11.8	0 45 47	0 45 28	0 45 09	0 44 50	0 07 52	0 07 48	0 07 45	0 07 42	6 34.9
23.8	45 55	45 37	45 18	44 00	09 06	09 02	08 58	08 55	40.9
35.7	45 57	45 39	45 20	45 02	10 20	10 16	10 11	10 07	46.9
47.7	42 51	42 33	42 15	41 58	11 34	11 29	11 24	11 19	52.9
59.7	41 38	41 21	41 03	40 46	12 47	12 41	12 36	12 31	58.9
2 11.6	0 40 18	0 40 01	0 39 44	0 39 28	0 13 59	0 13 54	0 13 48	0 13 42	7 04.8
23.6	38 51	38 35	38 19	38 03	15 11	15 05	14 59	14 52	10.8
35.6	37 18	37 03	36 47	36 32	16 23	16 16	16 09	16 02	16.8
47.5	35 39	35 24	35 09	34 54	17 33	17 26	17 19	17 11	22.8
59.5	33 53	33 39	33 25	33 11	18 43	18 35	18 28	18 20	28.8
3 05.5	0 32 59	0 32 45	0 32 32	0 32 18	0 19 52	0 19 44	0 19 36	0 19 27	7 34.8
11.5	32 03	31 49	31 36	31 23	21 01	20 52	20 43	20 34	40.7
17.5	31 05	30 52	30 40	30 27	22 08	21 59	21 50	21 40	46.7
23.4	30 07	29 54	29 42	29 29	23 15	23 05	22 55	22 45	52.7
29.4	29 07	28 55	28 43	28 31	24 20	24 10	24 00	23 50	58.7
3 35.4	0 28 06	0 27 54	0 27 42	0 27 31	0 25 25	0 25 14	0 25 04	0 24 53	8 04.7
41.4	27 03	26 52	26 41	26 30	26 28	26 17	26 06	25 55	10.7
47.4	26 00	25 49	25 38	25 28	27 31	27 19	27 08	26 56	16.6
53.4	24 55	24 45	24 35	24 25	28 32	28 20	28 08	27 56	22.6
59.3	[illegible] 50	23 40	23 30	23 21	29 32	29 20	29 07	28 55	28.6
4 05.3	0 22 43	0 22 34	0 22 25	0 22 15	0 30 31	0 30 18	0 30 06	0 29 53	8 34.6
11.3	21 36	21 27	21 18	21 09	31 29	31 16	31 02	30 49	40.6
17.3	20 28	20 19	20 11	20 03	32 25	32 12	31 58	31 44	46.6
23.3	19 19	19 11	19 03	18 55	33 20	33 06	32 52	32 38	52.5
29.3	18 09	18 01	17 54	17 46	34 14	33 59	33 45	33 31	58.5
4 35.2	0 16 58	0 16 51	0 16 44	0 16 37	0 35 57	0 35 42	0 35 27	0 35 12	9 10.5
41.2	15 47	15 40	15 34	15 27	37 34	37 18	37 03	36 47	22.5
47.2	14 35	14 29	14 23	14 17	39 05	38 49	38 33	38 16	34.4
53.2	13 22	13 17	13 11	13 06	40 30	40 13	39 56	39 39	46.4
59.2	12 09	12 04	11 59	11 54	41 48	41 31	41 13	40 56	58.4
5 05.2	0 10 56	0 10 51	0 10 47	0 10 42	0 42 59	0 42 41	0 42 23	0 42 06	10 10.3
11.1	09 42	09 38	09 34	09 30	44 04	43 45	43 27	43 09	22.3
17.1	08 27	08 24	08 20	08 17	45 01	44 42	44 23	44 05	34.3
23.1	07 12	07 10	07 07	07 04	45 51	45 31	45 12	44 53	46.2
29.1	05 57	05 55	05 53	05 50	46 33	46 14	45 54	45 35	58.2
5 35.1	0 04 42	0 04 40	0 04 38	0 04 37	0 47 08	0 46 48	0 46 29	0 46 09	11 10.2
41.1	03 27	03 25	03 24	03 23	47 35	47 15	46 55	46 36	22.1
47.0	02 11	02 10	02 10	02 09	47 54	47 34	47 15	46 55	34.1
53.0	00 55	00 55	00 55	00 55	48 06	47 46	47 26	47 06	46.1
57.4	00 00	00 00	00 00	00 00	48 10	47 50	47 30	47 10	58.0

Supplemental Correction to be Applied to the Vertical Angle Reading

Mean Time Hour Angle	Altitude													Mean Time Hour Angle
	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	
h m	′	′	′	′	′	′	′	′	′	′	′	′	′	h m
0 00	0	0	0	0	0	0	0	0	0	0	0	0	0	11 58
1 00	− 1	− 1	− 1	− 1	− 1	− 0	− 0	0	+ 0	+ 1	+ 1	+ 2	+ 2	10 58
2 00	4	4	3	3	2	− 1	− 1	0	1	2	4	6	9	9 58
3 00	8	7	6	5	4	3	2	0	2	4	7	11	17	8 58
3 59	12	11	9	8	6	4	2	0	3	6	11	17	26	7 59
4 59	15	14	12	10	8	6	3	0	4	8	14	21	32	6 59
5 59	−16	−15	−13	−11	− 8	− 6	− 3	0	+ 4	+ 8	+15	+23	+35	5 59

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EXPLANATIONS FOR THE STELLAR OBSERVATIONS

The data in this Ephemeris are arranged for the surveying practice of the Bureau of Land Management; the methods are useful in any survey where field observations are to be made for the ascertainment of the direction of a line in terms of angular value referred to the true meridian at that place.

In most cases, data are available as to the approximate latitude and longitude of the observing station, and preliminary determinations are made for the meridian and watch correction in terms of local mean time. The observations of the stars then follow on an observing program arranged for what is needed, and to suit the time of year, the latitude of the station, and other conditions that are factors.

A complete and well balanced stellar observing program will include: (1) the meridian passage of one star for time and latitude; (2) Polaris for azimuth and latitude; and (3) two well placed stars, one easterly and one westerly, both for azimuth, and one or both for time. The necessary verifications are thus accomplished. Instrumental uncertainties in the vertical angle readings are made apparent by this plan, and are compensated by taking the means of offsetting values. An observation may be made to verify only one or two values when the remainder are already well determined.

There are six stellar observing periods: (1) late afternoon, daylight; (2) early evening, twilight; (3) later p. m., after dark, illumination required; (4) after midnight, ditto; (5) early morning, twilight; and (6) after sunrise, daylight. The stars to be observed are chosen after deciding upon the observing period, and making the selection according to the desired position in hour angle and declination.

The time of a star's transit is to be reduced from the tabulated value for the Greenwich meridian to the longitude of the station; this is 10 seconds of time for each 15° (or one hour) of longitude, subtracted for west longitude (see table of Sidereal Conversions, page 27); this will give the correct local mean time at the moment of the star's meridian passage. The next step is to anticipate the probable local mean time of each observation, and the star's hour angle at that moment, to the east or to the west of the meridian.

The setting positions for the instrument in vertical angle (v) and in horizontal angle (A) are computed on the basis of the assumed hour angle (t), the star's declination (δ), and the known or approximate latitude (φ). This is done to secure a setting that is sufficiently accurate to bring the star within the field of the telescope, especially if the observation is to be by daylight, or twilight; less accuracy is needed just for the star's identification if the observation is to be made during starlight. The preliminary computations may be made with 4-place tables. The true values are obtained by reduction of the observations. The reductions for stellar observations are similar to the methods applicable to observations of the sun, and employ the same equations.

In all stellar observations, the true vertical angle (h) is equal to the observed vertical angle (v) minus the refraction (r) in zenith distance; there is no correction for parallax. In observations of the sun, the true vertical angle (h) is equal to (v) minus (r) plus parallax; see table, page 25.

In observations of the sun, the meridian passage and the hour angle (t) are in apparent solar time. The equation of time is applied to give the watch correction in terms of local mean time.

In observations of a star, the hour angle (t) is in terms of a sidereal rate; a subtraction of 10 seconds per hour will give the equivalent mean time hour angle. (Sidereal Conversions, page 27).

The following equations are regarded as the most useful for the methods stated above:

On the meridian, the vertical angle: $h = 90° - \varphi \pm \delta$; (or) $\varphi = 90° - h \pm \delta$

At any hour angle: $\sin h = \cos t \cos \varphi \cos \delta + \sin \varphi \sin \delta$

$$\therefore \cos t = \frac{\sin h}{\cos \varphi \cos \delta} - \tan \varphi \tan \delta$$

$$\therefore \cos A = \frac{\sin \delta}{\cos \varphi \cos h} - \tan \varphi \tan h$$

The product "$\sin \varphi \sin \delta$" and the fraction "$\frac{\sin \delta}{\cos \varphi \cos h}$" are negative for south declinations.

The product "$\cos t \cos \varphi \cos \delta$" is negative for hour angles exceeding six hours or 90°.

The product "$\tan \varphi \tan \delta$" is subtracted for north declinations; added for south declinations.

If the result for "cos A" is {positive / negative} the horizontal angle counts from the {north. / south.}

If the result for "cos t" is {positive / negative} the hour angle is {less / more} than six hours or 90°.

By a stellar equal-altitude observation, the meridian is determined as the mean of two direction-pointings; the latitude is not required; there are no corrections as to declination. A mean of the watch readings at the moment of each observation is equivalent to a reading at the time of the star's meridian passage. The latitude may be reduced from the maximum vertical angle at meridian passage.

The equations as written and explained above are applicable for the northern latitudes; suitable transpositions are required for observations in the southern latitudes.

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MEAN REFRACTIONS IN ZENITH DISTANCE AND SUN'S PARALLAX IN ALTITUDE

Bar. : 29.6 ins. Temp. : 50° F.

Apparent Altitude	Refraction	Sun's Par.	Apparent Altitude	Refraction	Sun's Par.	Apparent Altitude	Refraction	Sun's Par.
° ′	′ ″	″	° ′	′ ″	″	°	′ ″	″
7 30	6 53	8.8	12 0	4 25	8.7	25	2 3	8.1
7 40	6 46	8.8	12 30	4 15	8.7	26	1 58	8.0
7 50	6 37	8.8	13 0	4 5	8.7	27	1 53	7.9
8 0	6 30	8.8	13 30	3 56	8.7	28	1 48	7.9
8 10	6 22	8.8	14 0	3 47	8.6	29	1 44	7.8
8 20	6 15	8.8	14 30	3 39	8.6	30	1 40	7.7
8 30	6 8	8.8	15 0	3 32	8.6	32	1 32	7.6
8 40	6 2	8.8	15 30	3 25	8.6	34	1 25	7.4
8 50	5 55	8.8	16 0	3 19	8.6	36	1 19	7.2
9 0	5 49	8.8	16 30	3 13	8.5	38	1 14	7.0
9 10	5 43	8.8	17 0	3 7	8.5	40	1 9	6.8
9 20	5 38	8.8	17 30	3 1	8.5	42	1 4	6.6
9 30	5 32	8.8	18 0	2 56	8.5	44	1 0	6.4
9 40	5 26	8.8	18 30	2 51	8.4	46	0 56	6.2
9 50	5 21	8.8	19 0	2 46	8.4	48	0 52	6.0
10 0	5 16	8.8	19 30	2 42	8.4	50	0 48	5.7
10 20	5 6	8.8	20 0	2 37	8.4	55	0 40	5.1
10 40	4 57	8.7	21 0	2 29	8.3	60	0 33	4.4
11 0	4 48	8.7	22 0	2 22	8.2	65	0 27	3.8
11 20	4 40	8.7	23 0	2 15	8.2	70	0 21	3.0
11 40	4 32	8.7	24 0	2 9	8.1	80	0 10	1.5
12 0	4 25	8.7	25 0	2 3	8.1	90	0 0	0.0

Apparent altitude (observed vertical angle) : v
Sun's true altitude : h = v - refraction + parallax
Star's true altitude : h = v - refraction

True refraction : mean refraction x coefficient for barometric pressure x coefficient for temperature.

COEFFICIENTS TO APPLY TO MEAN REFRACTIONS FOR VARIATIONS IN BAROMETER AND TEMPERATURE

Barometer (Ins.)	Elevation above sea level (Feet)	Coefficient	Barometer (Ins.)	Elevation above sea level (Feet)	Coefficient	Barometer (Ins.)	Elevation above sea level (Feet)	Coefficient	Temperature (Fahr.)	Coefficient
30.5	-451	1.03	27.2	2,670	0.92	23.6	6,538	0.80	-10°	1.13
30.2	-181	1.02	26.9	2,972	.91	23.3	6,887	.79	0°	1.11
30.0	00	1.01	26.6	3,277	.90	23.0	7,239	.78	+10°	1.08
29.9	+ 91	1.01	26.3	3,586	.89	22.7	7,597	.77	20°	1.06
29.6	366	1.00	26.0	3,899	.88	22.4	7,960	.76	30°	1.04
29.3	643	.99	25.7	4,215	.87	22.1	8,327	.75	40°	1.02
29.0	924	.98	25.4	4,535	.86	21.8	8,700	.74	50°	1.00
28.7	1,207	.97	25.1	4,859	.85	21.5	9,077	.73	60°	.98
28.4	1,493	.96	24.8	5,186	.84	21.2	9,460	.72	70°	.96
28.1	1,783	.95	24.5	5,518	.83	20.9	9,848	.71	80°	.94
27.8	2,075	.94	24.2	5,854	.82	20.6	10,242	.70	90°	.93
27.5	2,371	.93	23.9	6,194	.81	20.3	10,642	.69	100°	.91
27.2	2,670	.92	23.6	6,538	.80	20.0	11,047	.68	+110°	.90

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CONVERSION OF TIME TO ARC

Minutes	Hours												
	0	1	2	3	4	5	6	7	8	9	10	11	12
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0	0 00	15 00	30 00	45 00	60 00	75 00	90 00	105 00	120 00	135 00	150 00	165 00	180 00
1	0 15	15 15	30 15	45 15	60 15	75 15	90 15	105 15	120 15	135 15	150 15	165 15	180 15
2	0 30	15 30	30 30	45 30	60 30	75 30	90 30	105 30	120 30	135 30	150 30	165 30	180 30
3	0 45	15 45	30 45	45 45	60 45	75 45	90 45	105 45	120 45	135 45	150 45	165 45	180 45
4	1 00	16 00	31 00	46 00	61 00	76 00	91 00	106 00	121 00	136 00	151 00	166 00	181 00
5	1 15	16 15	31 15	46 15	61 15	76 15	91 15	106 15	121 15	136 15	151 15	166 15	181 15
6	1 30	16 30	31 30	46 30	61 30	76 30	91 30	106 30	121 30	136 30	151 30	166 30	181 30
7	1 45	16 45	31 45	46 45	61 45	76 45	91 45	106 45	121 45	136 45	151 45	166 45	181 45
8	2 00	17 00	32 00	47 00	62 00	77 00	92 00	107 00	122 00	137 00	152 00	167 00	182 00
9	2 15	17 15	32 15	47 15	62 15	77 15	92 15	107 15	122 15	137 15	152 15	167 15	182 15
10	2 30	17 30	32 30	47 30	62 30	77 30	92 30	107 30	122 30	137 30	152 30	167 30	182 30
11	2 45	17 45	32 45	47 45	62 45	77 45	92 45	107 45	122 45	137 45	152 45	167 45	182 45
12	3 00	18 00	33 00	48 00	63 00	78 00	93 00	108 00	123 00	138 00	153 00	168 00	183 00
13	3 15	18 15	33 15	48 15	63 15	78 15	93 15	108 15	123 15	138 15	153 15	168 15	183 15
14	3 30	18 30	33 30	48 30	63 30	78 30	93 30	108 30	123 30	138 30	153 30	168 30	183 30
15	3 45	18 45	33 45	48 45	63 45	78 45	93 45	108 45	123 45	138 45	153 45	168 45	183 45
16	4 00	19 00	34 00	49 00	64 00	79 00	94 00	109 00	124 00	139 00	154 00	169 00	184 00
17	4 15	19 15	34 15	49 15	64 15	79 15	94 15	109 15	124 15	139 15	154 15	169 15	184 15
18	4 30	19 30	34 30	49 30	64 30	79 30	94 30	109 30	124 30	139 30	154 30	169 30	184 30
19	4 45	19 45	34 45	49 45	64 45	79 45	94 45	109 45	124 45	139 45	154 45	169 45	184 45
20	5 00	20 00	35 00	50 00	65 00	80 00	95 00	110 00	125 00	140 00	155 00	170 00	185 00
21	5 15	20 15	35 15	50 15	65 15	80 15	95 15	110 15	125 15	140 15	155 15	170 15	185 15
22	5 30	20 30	35 30	50 30	65 30	80 30	95 30	110 30	125 30	140 30	155 30	170 30	185 30
23	5 45	20 45	35 45	50 45	65 45	80 45	95 45	110 45	125 45	140 45	155 45	170 45	185 45
24	6 00	21 00	36 00	51 00	66 00	81 00	96 00	111 00	126 00	141 00	156 00	171 00	186 00
25	6 15	21 15	36 15	51 15	66 15	81 15	96 15	111 15	126 15	141 15	156 15	171 15	186 15
26	6 30	21 30	36 30	51 30	66 30	81 30	96 30	111 30	126 30	141 30	156 30	171 30	186 30
27	6 45	21 45	36 45	51 45	66 45	81 45	96 45	111 45	126 45	141 45	156 45	171 45	186 45
28	7 00	22 00	37 00	52 00	67 00	82 00	97 00	112 00	127 00	142 00	157 00	172 00	187 00
29	7 15	22 15	37 15	52 15	67 15	82 15	97 15	112 15	127 15	142 15	157 15	172 15	187 15
30	7 30	22 30	37 30	52 30	67 30	82 30	97 30	112 30	127 30	142 30	157 30	172 30	187 30
31	7 45	22 45	37 45	52 45	67 45	82 45	97 45	112 45	127 45	142 45	157 45	172 45	187 45
32	8 00	23 00	38 00	53 00	68 00	83 00	98 00	113 00	128 00	143 00	158 00	173 00	188 00
33	8 15	23 15	38 15	53 15	68 15	83 15	98 15	113 15	128 15	143 15	158 15	173 15	188 15
34	8 30	23 30	38 30	53 30	68 30	83 30	98 30	113 30	128 30	143 30	158 30	173 30	188 30
35	8 45	23 45	38 45	53 45	68 45	83 45	98 45	113 45	128 45	143 45	158 45	173 45	188 45
36	9 00	24 00	39 00	54 00	69 00	84 00	99 00	114 00	129 00	144 00	159 00	174 00	189 00
37	9 15	24 15	39 15	54 15	69 15	84 15	99 15	114 15	129 15	144 15	159 15	174 15	189 15
38	9 30	24 30	39 30	54 30	69 30	84 30	99 30	114 30	129 30	144 30	159 30	174 30	189 30
39	9 45	24 45	39 45	54 45	69 45	84 45	99 45	114 45	129 45	144 45	159 45	174 45	189 45
40	10 00	25 00	40 00	55 00	70 00	85 00	100 00	115 00	130 00	145 00	160 00	175 00	190 00
41	10 15	25 15	40 15	55 15	70 15	85 15	100 15	115 15	130 15	145 15	160 15	175 15	190 15
42	10 30	25 30	40 30	55 30	70 30	85 30	100 30	115 30	130 30	145 30	160 30	175 30	190 30
43	10 45	25 45	40 45	55 45	70 45	85 45	100 45	115 45	130 45	145 45	160 45	175 45	190 45
44	11 00	26 00	41 00	56 00	71 00	86 00	101 00	116 00	131 00	146 00	161 00	176 00	191 00
45	11 15	26 15	41 15	56 15	71 15	86 15	101 15	116 15	131 15	146 15	161 15	176 15	191 15
46	11 30	26 30	41 30	56 30	71 30	86 30	101 30	116 30	131 30	146 30	161 30	176 30	191 30
47	11 45	26 45	41 45	56 45	71 45	86 45	101 45	116 45	131 45	146 45	161 45	176 45	191 45
48	12 00	27 00	42 00	57 00	72 00	87 00	102 00	117 00	132 00	147 00	162 00	177 00	192 00
49	12 15	27 15	42 15	57 15	72 15	87 15	102 15	117 15	132 15	147 15	162 15	177 15	192 15
50	12 30	27 30	42 30	57 30	72 30	87 30	102 30	117 30	132 30	147 30	162 30	177 30	192 30
51	12 45	27 45	42 45	57 45	72 45	87 45	102 45	117 45	132 45	147 45	162 45	177 45	192 45
52	13 00	28 00	43 00	58 00	73 00	88 00	103 00	118 00	133 00	148 00	163 00	178 00	193 00
53	13 15	28 15	43 15	58 15	73 15	88 15	103 15	118 15	133 15	148 15	163 15	178 15	193 15
54	13 30	28 30	43 30	58 30	73 30	88 30	103 30	118 30	133 30	148 30	163 30	178 30	193 30
55	13 45	28 45	43 45	58 45	73 45	88 45	103 45	118 45	133 45	148 45	163 45	178 45	193 45
56	14 00	29 00	44 00	59 00	74 00	89 00	104 00	119 00	134 00	149 00	164 00	179 00	194 00
57	14 15	29 15	44 15	59 15	74 15	89 15	104 15	119 15	134 15	149 15	164 15	179 15	194 15
58	14 30	29 30	44 30	59 30	74 30	89 30	104 30	119 30	134 30	149 30	164 30	179 30	194 30
59	14 45	29 45	44 45	59 45	74 45	89 45	104 45	119 45	134 45	149 45	164 45	179 45	194 45
60	15 00	30 00	45 00	60 00	75 00	90 00	105 00	120 00	135 00	150 00	165 00	180 00	195 00

Note: To convert seconds of time, use the first column for the number of seconds and the second column for the converted value in minutes and seconds of arc; for exampl. 33 seconds of time = 8′15″ in arc.

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CONVERSION OF ARC TO TIME

° ′	h m m s	° ′	h m m s	°	h m	°	h m	°	h m	°	h m	″	s
0	0 00	30	2 00	60	4 00	90	6 00	120	8 00	150	10 00	0	0,00
1	0 04	31	2 04	61	4 04	91	6 04	121	8 04	151	10 04	2	0,13
2	0 08	32	2 08	62	4 08	92	6 08	122	8 08	152	10 08	4	0,27
3	0 12	33	2 12	63	4 12	93	6 12	123	8 12	153	10 12	6	0,40
4	0 16	34	2 16	64	4 16	94	6 16	124	8 16	154	10 16	8	0,53
5	0 20	35	2 20	65	4 20	95	6 20	125	8 20	155	10 20	10	0,67
6	0 24	36	2 24	66	4 24	96	6 24	126	8 24	156	10 24	12	0,80
7	0 28	37	2 28	67	4 28	97	6 28	127	8 28	157	10 28	14	0,93
8	0 32	38	2 32	68	4 32	98	6 32	128	8 32	158	10 32	16	1,07
9	0 36	39	2 36	69	4 36	99	6 36	129	8 36	159	10 36	18	1,20
10	0 40	40	2 40	70	4 40	100	6 40	130	8 40	160	10 40	20	1,33
11	0 44	41	2 44	71	4 44	101	6 44	131	8 44	161	10 44	22	1,47
12	0 48	42	2 48	72	4 48	102	6 48	132	8 48	162	10 48	24	1,60
13	0 52	43	2 52	73	4 52	103	6 52	133	8 52	163	10 52	26	1,73
14	0 56	44	2 56	74	4 56	104	6 56	134	8 56	164	10 56	28	1,87
15	1 00	45	3 00	75	5 00	105	7 00	135	9 00	165	11 00	30	2,00
16	1 04	46	3 04	76	5 04	106	7 04	136	9 04	166	11 04	32	2,13
17	1 08	47	3 08	77	5 08	107	7 08	137	9 08	167	11 08	34	2,27
18	1 12	48	3 12	78	5 12	108	7 12	138	9 12	168	11 12	36	2,40
19	1 16	49	3 16	79	5 16	109	7 16	139	9 16	169	11 16	38	2,53
20	1 20	50	3 20	80	5 20	110	7 20	140	9 20	170	11 20	40	2,67
21	1 24	51	3 24	81	5 24	111	7 24	141	9 24	171	11 24	42	2,80
22	1 28	52	3 28	82	5 28	112	7 28	142	9 28	172	11 28	44	2,93
23	1 32	53	3 32	83	5 32	113	7 32	143	9 32	173	11 32	46	3,07
24	1 36	54	3 36	84	5 36	114	7 36	144	9 36	174	11 36	48	3,20
25	1 40	55	3 40	85	5 40	115	7 40	145	9 40	175	11 40	50	3,33
26	1 44	56	3 44	86	5 44	116	7 44	146	9 44	176	11 44	52	3,47
27	1 48	57	3 48	87	5 48	117	7 48	147	9 48	177	11 48	54	3,60
28	1 52	58	3 52	88	5 52	118	7 52	148	9 52	178	11 52	56	3,73
29	1 56	59	3 56	89	5 56	119	7 56	149	9 56	179	11 56	58	3,87
30	2 00	60	4 00	90	6 00	120	8 00	150	10 00	180	12 00	60	4,00

Degrees of arc convert to hours and minutes of time ; minutes of arc convert to minutes and seconds of time . See right hand column for conversion of seconds of arc to seconds of time .

SIDEREAL CONVERSIONS

		Longitude						
		0° 00′	2° 30′	5° 00′	7° 30′	10° 00′	12° 30′	15° 00′
		Minutes						
Long.	Hours	0	10	20	30	40	50	60
°		m s	m s	m s	m s	m s	m s	m s
0	0	0 00	0 02	0 03	0 05	0 07	0 08	0 10
15	1	0 10	0 11	0 13	0 15	0 16	0 18	0 20
30	2	0 20	0 21	0 23	0 25	0 26	0 28	0 30
45	3	0 30	0 31	0 33	0 34	0 36	0 38	0 39
60	4	0 39	0 41	0 43	0 44	0 46	0 48	0 49
75	5	0 49	0 51	0 53	0 54	0 56	0 57	0 59
90	6	0 59	1 01	1 02	1 04	1 06	1 07	1 09
105	7	1 09	1 11	1 12	1 14	1 15	1 17	1 19
120	8	1 19	1 20	1 22	1 24	1 25	1 27	1 29
135	9	1 29	1 30	1 32	1 34	1 35	1 37	1 38
150	10	1 38	1 40	1 42	1 43	1 45	1 47	1 48
165	11	1 48	1 50	1 52	1 53	1 55	1 56	1 58
180	12	1 58	2 00	2 01	2 03	2 05	2 06	2 08

Sidereal into mean solar time : To be subtracted from a sidereal time interval : Argument , hours and minutes of sidereal interval .

Mean solar into sidereal time : To be added to a mean time interval : Argument , hours and minutes of mean time interval .

For any stellar observation : Amount to be subtracted from the Greenwich mean time of transit or elongation to obtain local mean time : Argument , longitude west from Greenwich ; add for longitudes east from Greenwich .

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FOR FINDING THE VERTICAL AND HORIZONTAL ANGLES OF A STAR
Natural Sines, Cosines, and Tangents

For sin tan	tan	sin	For cos only	For sin tan	tan	sin	For cos only	For sin tan	tan	sin	For cos only
0°00'	.0000	.0000	90°00'	15°00'	.2679	.2588	75°00'	30°00'	.5774	.5000	60°00'
15'	.0044	.0044	45'	15'	.2726	.2630	45'	15'	.5832	.5038	45'
30'	.0087	.0087	30'	30'	.2773	.2672	30'	30'	.5890	.5075	30'
45'	.0131	.0131	15'	45'	.2820	.2714	15'	45'	.5949	.5113	15'
1°00'	.0175	.0175	89°00'	16°00'	.2867	.2756	74°00'	31°00'	.6009	.5150	59°00'
15'	.0218	.0218	45'	15'	.2915	.2798	45'	15'	.6068	.5188	45'
30'	.0262	.0262	30'	30'	.2962	.2840	30'	30'	.6128	.5225	30'
45'	.0306	.0305	15'	45'	.3010	.2882	15'	45'	.6188	.5262	15'
2°00'	.0349	.0349	88°00'	17°00'	.3057	.2924	73°00'	32°00'	.6249	.5299	58°00'
15'	.0393	.0393	45'	15'	.3105	.2965	45'	15'	.6310	.5336	45'
30'	.0437	.0436	30'	30'	.3153	.3007	30'	30'	.6371	.5373	30'
45'	.0480	.0480	15'	45'	.3201	.3049	15'	45'	.6432	.5410	15'
3°00'	.0524	.0523	87°00'	18°00'	.3249	.3090	72°00'	33°00'	.6494	.5446	57°00'
15'	.0568	.0567	45'	15'	.3298	.3132	45'	15'	.6556	.5483	45'
30'	.0612	.0610	30'	30'	.3346	.3173	30'	30'	.6619	.5519	30'
45'	.0655	.0654	15'	45'	.3395	.3214	15'	45'	.6682	.5556	15'
4°00'	.0699	.0698	86°00'	19°00'	.3443	.3256	71°00'	34°00'	.6745	.5592	56°00'
15'	.0743	.0741	45'	15'	.3492	.3297	45'	15'	.6809	.5628	45'
30'	.0787	.0785	30'	30'	.3541	.3338	30'	30'	.6873	.5664	30'
45'	.0831	.0828	15'	45'	.3590	.3379	15'	45'	.6937	.5700	15'
5°00'	.0875	.0872	85°00'	20°00'	.3640	.3420	70°00'	35°00'	.7002	.5736	55°00'
15'	.0919	.0915	45'	15'	.3689	.3461	45'	15'	.7067	.5771	45'
30'	.0963	.0958	30'	30'	.3739	.3502	30'	30'	.7133	.5807	30'
45'	.1007	.1002	15'	45'	.3789	.3543	15'	45'	.7199	.5842	15'
6°00'	.1051	.1045	84°00'	21°00'	.3839	.3584	69°00'	36°00'	.7265	.5878	54°00'
15'	.1095	.1089	45'	15'	.3889	.3624	45'	15'	.7332	.5913	45'
30'	.1139	.1132	30'	30'	.3939	.3665	30'	30'	.7400	.5948	30'
45'	.1184	.1175	15'	45'	.3990	.3706	15'	45'	.7467	.5983	15'
7°00'	.1228	.1219	83°00'	22°00'	.4040	.3746	68°00'	37°00'	.7536	.6018	53°00'
15'	.1272	.1262	45'	15'	.4091	.3786	45'	15'	.7604	.6053	45'
30'	.1317	.1305	30'	30'	.4142	.3827	30'	30'	.7673	.6088	30'
45'	.1361	.1349	15'	45'	.4193	.3867	15'	45'	.7743	.6122	15'
8°00'	.1405	.1392	82°00'	23°00'	.4245	.3907	67°00'	38°00'	.7813	.6157	52°00'
15'	.1450	.1435	45'	15'	.4296	.3947	45'	15'	.7883	.6191	45'
30'	.1495	.1478	30'	30'	.4348	.3987	30'	30'	.7954	.6225	30'
45'	.1539	.1521	15'	45'	.4400	.4027	15'	45'	.8026	.6259	15'
9°00'	.1584	.1564	81°00'	24°00'	.4452	.4067	66°00'	39°00'	.8098	.6293	51°00'
15'	.1629	.1607	45'	15'	.4505	.4107	45'	15'	.8170	.6327	45'
30'	.1673	.1650	30'	30'	.4557	.4147	30'	30'	.8243	.6361	30'
45'	.1718	.1693	15'	45'	.4610	.4187	15'	45'	.8317	.6394	15'
10°00'	.1763	.1736	80°00'	25°00'	.4663	.4226	65°00'	40°00'	.8391	.6428	50°00'
15'	.1808	.1779	45'	15'	.4716	.4266	45'	15'	.8466	.6461	45'
30'	.1853	.1822	30'	30'	.4770	.4305	30'	30'	.8541	.6494	30'
45'	.1899	.1865	15'	45'	.4823	.4345	15'	45'	.8617	.6528	15'
11°00'	.1944	.1908	79°00'	26°00'	.4877	.4384	64°00'	41°00'	.8693	.6561	49°00'
15'	.1989	.1951	45'	15'	.4931	.4423	45'	15'	.8770	.6593	45'
30'	.2035	.1994	30'	30'	.4986	.4462	30'	30'	.8847	.6626	30'
45'	.2080	.2036	15'	45'	.5040	.4501	15'	45'	.8925	.6659	15'
12°00'	.2126	.2079	78°00'	27°00'	.5095	.4540	63°00'	42°00'	.9004	.6691	48°00'
15'	.2171	.2122	45'	15'	.5150	.4579	45'	15'	.9083	.6724	45'
30'	.2217	.2164	30'	30'	.5206	.4617	30'	30'	.9163	.6756	30'
45'	.2263	.2207	15'	45'	.5261	.4656	15'	45'	.9244	.6788	15'
13°00'	.2309	.2250	77°00'	28°00'	.5317	.4695	62°00'	43°00'	.9325	.6820	47°00'
15'	.2355	.2292	45'	15'	.5373	.4733	45'	15'	.9407	.6852	45'
30'	.2401	.2334	30'	30'	.5430	.4772	30'	30'	.9490	.6884	30'
45'	.2447	.2377	15'	45'	.5486	.4810	15'	45'	.9573	.6915	15'
14°00'	.2493	.2419	76°00'	29°00'	.5543	.4848	61°00'	44°00'	.9657	.6947	46°00'
15'	.2540	.2462	45'	15'	.5600	.4886	45'	15'	.9742	.6978	45'
30'	.2586	.2504	30'	30'	.5658	.4924	30'	30'	.9827	.7009	30'
45'	.2633	.2546	15'	45'	.5715	.4962	15'	45'	.9913	.7040	15'
15°00'	.2679	.2588	75°00'	30°00'	.5774	.5000	60°00'	45°00'	1.0000	.7071	45°00'

For sin tan	tan	cos	For cos only	For sin tan	tan	cos	For cos only	For sin tan	tan	cos	For cos only

On the meridian, the vertical angle: $h = 90° - \varphi \pm \delta$

At any hour angle: $\sin h = \cos t \cos \varphi \cos \delta + \sin \varphi \sin \delta$

The product: "$\sin \varphi \sin \delta$" is negative for south declinations.

The product: "$\cos t \cos \varphi \cos \delta$" is negative for hour angles exceeding six hours or 90°.

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FOR FINDING THE VERTICAL AND HORIZONTAL ANGLES OF A STAR
Natural Sines, Cosines, and Tangents

For sin tan	tan		sin		For cos only
45°00'	1.0000	88	.7071	31	45°00'
15'	1.0088	88	.7102	31	45'
30'	1.0176	89	.7133	30	30'
45'	1.0265	90	.7163	30	15'
46°00'	1.0355	91	.7193	31	44°00'
15'	1.0446	92	.7224	30	45'
30'	1.0538	92	.7254	30	30'
45'	1.0630	94	.7284	30	15'
47°00'	1.0724	94	.7314	29	43°00'
15'	1.0818	95	.7343	30	45'
30'	1.0913	96	.7373	29	30'
45'	1.1009	97	.7402	29	15'
48°00'	1.1106	98	.7431	30	42°00'
15'	1.1204	99	.7461	29	45'
30'	1.1303	100	.7490	28	30'
45'	1.1403	101	.7518	29	15'
49°00'	1.1504	102	.7547	29	41°00'
15'	1.1606	102	.7576	28	45'
30'	1.1708	104	.7604	28	30'
45'	1.1812	106	.7632	28	15'
50°00'	1.1918	106	.7660	28	40°00'
15'	1.2024	107	.7688	28	45'
30'	1.2131	108	.7716	28	30'
45'	1.2239	110	.7744	27	15'
51°00'	1.2349	111	.7771	28	39°00'
15'	1.2460	112	.7799	27	45'
30'	1.2572	113	.7826	27	30'
45'	1.2685	114	.7853	27	15'
52°00'	1.2799	116	.7880	27	38°00'
15'	1.2915	117	.7907	27	45'
30'	1.3032	119	.7934	26	30'
45'	1.3151	119	.7960	26	15'
53°00'	1.3270	122	.7986	27	37°00'
15'	1.3392	122	.8013	26	45'
30'	1.3514	124	.8039	25	30'
45'	1.3638	126	.8064	26	15'
54°00'	1.3764	127	.8090	26	36°00'
15'	1.3891	128	.8116	25	45'
30'	1.4019	131	.8141	25	30'
45'	1.4150	131	.8166	26	15'
55°00'	1.4281	134	.8192	24	35°00'
15'	1.4415	135	.8216	25	45'
30'	1.4550	137	.8241	25	30'
45'	1.4687	139	.8266	24	15'
56°00'	1.4826	140	.8290	25	34°00'
15'	1.4966	142	.8315	24	45'
30'	1.5108	145	.8339	24	30'
45'	1.5253	146	.8363	24	15'
57°00'	1.5399	148	.8387	23	33°00'
15'	1.5547	150	.8410	24	45'
30'	1.5697	152	.8434	23	30'
45'	1.5849	154	.8457	23	15'
58°00'	1.6003	157	.8480	24	32°00'
15'	1.6160	159	.8504	22	45'
30'	1.6319	160	.8526	23	30'
45'	1.6479	164	.8549	23	15'
59°00'	1.6643	165	.8572	22	31°00'
15'	1.6808	169	.8594	22	45'
30'	1.6977	170	.8616	22	30'
45'	1.7147	174	.8638	22	15'
60°00'	1.7321		.8660		30°00'
For sin tan	tan		cos		For cos only

For sin tan	tan		sin		For cos only
60°00'	1.7321	175	.8660	22	30°00'
15'	1.7496	179	.8682	22	45'
30'	1.7675	181	.8704	21	30'
45'	1.7856	184	.8725	21	15'
61°00'	1.8040	188	.8746	21	29°00'
15'	1.8228	190	.8767	21	45'
30'	1.8418	193	.8788	21	30'
45'	1.8611	196	.8809	20	15'
62°00'	1.8807	200	.8829	21	28°00'
15'	1.9007	203	.8850	20	45'
30'	1.9210	206	.8870	20	30'
45'	1.9416	210	.8890	20	15'
63°00'	1.9626	214	.8910	20	27°00'
15'	1.9840	217	.8930	19	45'
30'	2.0057	221	.8949	20	30'
45'	2.0278	225	.8969	19	15'
64°00'	2.0503	229	.8988	19	26°00'
15'	2.0732	233	.9007	19	45'
30'	2.0965	238	.9026	19	30'
45'	2.1203	242	.9046	18	15'
65°00'	2.1445	247	.9063	18	25°00'
15'	2.1692	251	.9081	19	45'
30'	2.1943	256	.9100	18	30'
45'	2.2199	261	.9118	17	15'
66°00'	2.2460	267	.9135	18	24°00'
15'	2.2727	271	.9153	18	45'
30'	2.2998	278	.9171	17	30'
45'	2.3276	283	.9188	17	15'
67°00'	2.3559	288	.9205	17	23°00'
15'	2.3847	295	.9222	17	45'
30'	2.4142	301	.9239	16	30'
45'	2.4443	308	.9255	17	15'
68°00'	2.4751	314	.9272	16	22°00'
15'	2.5065	321	.9288	16	45'
30'	2.5386	329	.9304	16	30'
45'	2.5715	336	.9320	16	15'
69°00'	2.6051	344	.9336	15	21°00'
15'	2.6395	351	.9351	16	45'
30'	2.6746	360	.9367	15	30'
45'	2.7106	369	.9382	15	15'
70°00'	2.7475	377	.9397	15	20°00'
15'	2.7852	387	.9412	14	45'
30'	2.8239	397	.9426	15	30'
45'	2.8636	406	.9441	14	15'
71°00'	2.9042	417	.9455	14	19°00'
15'	2.9459	428	.9469	14	45'
30'	2.9887	439	.9483	14	30'
45'	3.0326	451	.9497	14	15'
72°00'	3.0777	463	.9511	13	18°00'
15'	3.1240	476	.9524	13	45'
30'	3.1716	489	.9537	13	30'
45'	3.2205	504	.9550	13	15'
73°00'	3.2709	517	.9563	13	17°00'
15'	3.3226	533	.9576	12	45'
30'	3.3759	549	.9588	12	30'
45'	3.4308	566	.9600	13	15'
74°00'	3.4874	583	.9613	12	16°00'
15'	3.5457	602	.9625	11	45'
30'	3.6059	621	.9636	12	30'
45'	3.6680	641	.9648	11	15'
75°00'	3.7321		.9659		15°00'
For sin tan	tan		cos		For cos only

For sin	sin		For cos only
75°00'	.9659	11	15°00'
15'	.9670	11	45'
30'	.9681	11	30'
45'	.9692	11	15'
76°00'	.9703	10	14°00'
15'	.9713	11	45'
30'	.9724	10	30'
45'	.9734	10	15'
77°00'	.9744	9	13°00'
15'	.9753	10	45'
30'	.9763	9	30'
45'	.9772	9	15'
78°00'	.9781	9	12°00'
15'	.9790	9	45'
30'	.9799	8	30'
45'	.9808	8	15'
79°00'	.9816	9	11°00'
15'	.9825	8	45'
30'	.9833	7	30'
45'	.9840	8	15'
80°00'	.9848	8	10°00'
15'	.9856	7	45'
30'	.9863	7	30'
45'	.9870	7	15'
81°00'	.9877	7	9°00'
15'	.9884	6	45'
30'	.9890	7	30'
45'	.9897	6	15'
82°00'	.9903	6	8°00'
15'	.9909	5	45'
30'	.9914	6	30'
45'	.9920	5	15'
83°00'	.9925	6	7°00'
15'	.9931	5	45'
30'	.9936	5	30'
45'	.9941	4	15'
84°00'	.9945	5	6°00'
15'	.9950	4	45'
30'	.9954	4	30'
45'	.9958	4	15'
85°00'	.9962	4	5°00'
15'	.9966	3	45'
30'	.9969	3	30'
45'	.9973	3	15'
86°00'	.9976	3	4°00'
15'	.9979	2	45'
30'	.9981	3	30'
45'	.9984	2	15'
87°00'	.9986	2	3°00'
15'	.9988	2	45'
30'	.9990	2	30'
45'	.9992	2	15'
88°00'	.9994	1	2°00'
15'	.9995	2	45'
30'	.9997	1	30'
45'	.9998	1	15'
89°00'	.9998	1	1°00'
15'	.9999	1	45'
30'	1.0000	0	30'
45'	1.0000	0	15'
90°00'	1.0000		0°00'
For sin	sin		For cos only

The horizontal angle may be found from the equation: $\cos A = \frac{\sin \delta}{\cos \phi \cos h} - \tan \phi \tan h$

"Sin δ" is negative for south declinations.

If the result for "cos A" is {positive / negative} the horizontal angle counts from the {north. / south.}

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PREPARING FOR THE OBSERVATIONS

The modern solar transit, as developed for surveying the public lands, affords a ready determination of the factors of time, latitude, and azimuth, which are the starting values employed in the stellar observations. The latter are designed to supply the desired refinements in the values, better than the limits of the solar unit. A carefully determined meridian is used in making the instrumental adjustments and tests, preliminary to the running of the lines, and the direction of the latter is verified at frequent intervals.

Since few solar transits are in general use, consideration is to be given to the preliminary steps to be taken when the factors of time, latitude, and azimuth are unknown, or are only roughly approximate. If nothing is to be assumed as known, or approximate, it is well to begin with the equal-altitude observation on the sun, or one of the known bright stars, by which the latitude, azimuth, and time may all be derived.

If the uncertainty in latitude is not more than 2′ or 3′, an altitude observation of the sun, or any known bright star, may be made, from which to derive preliminary values for time and azimuth, using the approximate latitude as the factor until its value can be suitably corrected. An observation of Polaris at elongation may be made without exact data as to the time or latitude.

An interpretation of the terms "approximate" and "rough" may be helpful in clarifying what is intended. These terms have been used with reference to the preliminary values for time, latitude, and azimuth, to be regarded as more or less reliable for the identification of a star by vertical and horizontal angles. For this purpose and for a starlight period, a rough estimate based upon incomplete data, employed with good judgment, may allow a fairly wide tolerance and yet be entirely acceptable for the identification of a star without the slightest doubt. However, if a daylight or twilight observing period is proposed the setting positions should be sufficiently good to bring the star within the middle-third of the telescope. The time of passage across the field is slightly more than 4 minutes.

Some practice in making the observations by starlight is needed, or will be helpful, before making the twilight or daylight observations, and for the latter it is desirable to prepare the data for several positions for the sequence of settings at intervals that will allow for the reading of angles and the instrumental reversals. Obviously, the twilight or daylight observation will depend very largely upon the clearness of the atmosphere.

In all cases the finding positions are for the identification of a star, and having served that purpose the observation proceeds with the required care in all detail. The arrangement of the data and the suggestions as to the observing plan are intended to simplify the steps. The methods for a well-balanced observing program are good for results within ± 6 seconds of time; ± 15″ in latitude and azimuth; for vernier readings to the nearest 30″; due care being given to the necessary refinements in the observing and in the reductions; these limits are with reference to the one-minute transit ordinarily supplied to the field parties.

The setting positions for the instrument, in vertical angle (v or h for this purpose), and in horizontal angle (A) counting from the meridian (or from an approximate north and south line) are derived from the equations after having determined the hour angle (t) for the anticipated moment for the observation.

The 4-place tables may be used to shorten the work, as being sufficient for the star's identification or finding.

Example.

Star: 6-10 1.1
α Tauri (Aldebaran)
δ : +16°28′

$\sin h = \cos t \cos \varphi \cos \delta + \sin \varphi \sin \delta$

	cos	sin
t =	.330	
φ =	.816	.578
δ =	.959	.283
	.2582	.1636 (Products)
		.2582
sin h =		.4218 (Sum)
h = 24°57′		

φ : Approximate latitude: 35°18′

t : Anticipated hour angle: 4ʰ43ᵐ = (70°45′)

$\cos A = \dfrac{\sin \delta}{\cos \varphi \cos h} - \tan \varphi \tan h$

	cos	sin	tan
	.816		.708
		.283	
	.907	———	.465
	.7401		.3292 (Products)
		.3824	.3824 (Fraction)
cos A =			.0532 (Diff. +)
A = 86°57′ (Counting from the north)			

In general make each reading to the nearest third place, regarding the values as merely approximate. The results are good as finding positions, or for the star's identification. The true values are obtained by careful reduction of the observations.

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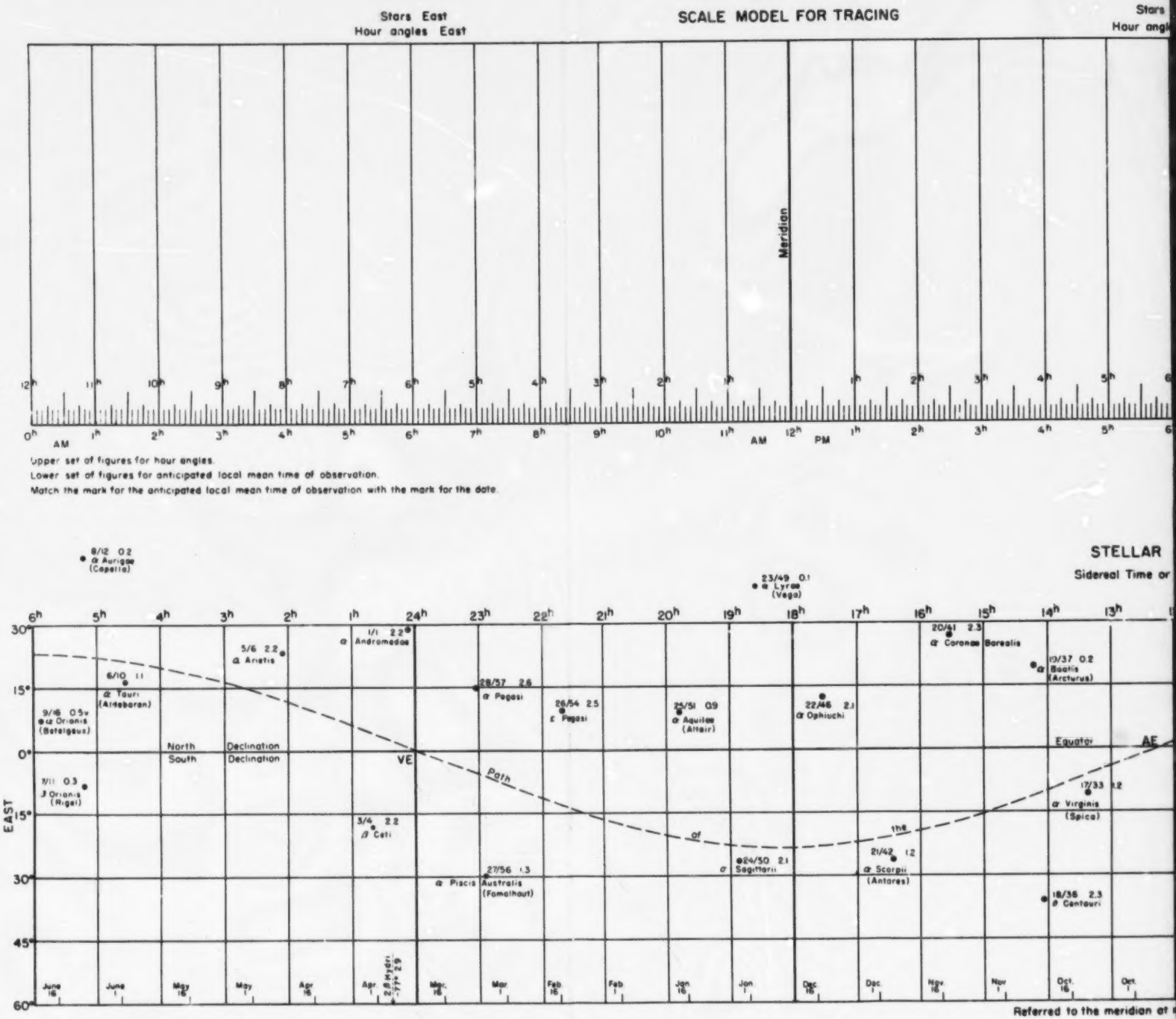
Stars East
Hour angles East
SCALE MODEL FOR TRACING
Stars
Hour angl
Meridian
0h AM 1h 2h 3h 4h 5h 6h 7h 8h 9h 10h 11h AM 12h PM 1h 2h 3h 4h 5h
12h 11h 10h 9h 8h 7h 6h 5h 4h 3h 2h 1h 1h 2h 3h 4h 5h
Upper set of figures for hour angles.
Lower set of figures for anticipated local mean time of observation.
Match the mark for the anticipated local mean time of observation with the mark for the date.
STELLAR
Sidereal Time or
6h 5h 4h 3h 2h 1h 24h 23h 22h 21h 20h 19h 18h 17h 16h 15h 14h 13h
30° 15° 0° 15° 30° 45° 60°
EAST
8/12 0.2 α Aurigae (Capella)
23/49 0.1 α Lyrae (Vega)
6/10 1.1 α Tauri (Aldebaran)
5/6 2.2 α Arietis
1/1 2.2 α Andromedae
20/41 2.3 α Coronae Borealis
19/37 0.2 α Bootis (Arcturus)
9/16 0.5v α Orionis (Betelgeuse)
28/37 2.6 α Pegasi
26/54 2.5 ε Pegasi
25/51 0.9 α Aquilae (Altair)
22/46 2.1 α Ophiuchi
North Declination
South Declination
VE
Equator
AE
Path
7/11 0.3 β Orionis (Rigel)
3/4 2.2 β Ceti
17/33 1.2 α Virginis (Spica)
of the
24/50 2.1 σ Sagittarii
21/42 1.2 α Scorpii (Antares)
27/56 1.3 α Piscis Australis (Fomalhaut)
18/36 2.3 β Centauri
June 16 June 1 May 16 May 1 Apr 16 Apr 1 Mar 16 Mar 1 Feb 16 Feb 1 Jan 16 Jan 1 Dec 16 Dec 1 Nov 16 Nov 1 Oct 16 Oct 1
Referred to the meridian at

31

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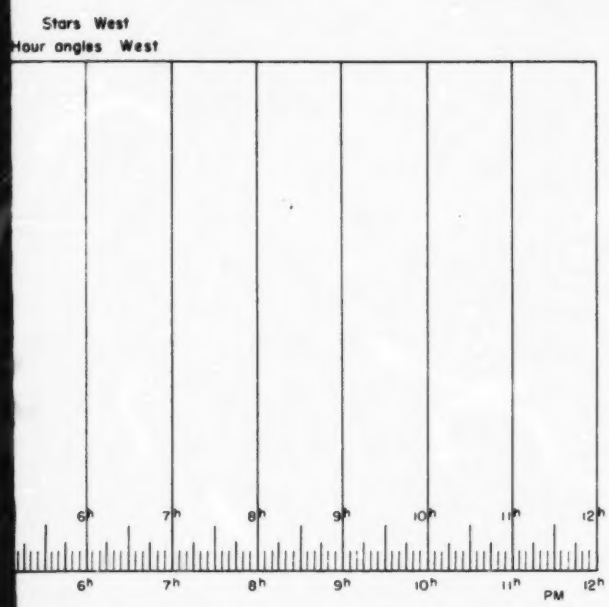
31



THE STAR CHART

The chart visualizes the positions of the selected stars. The right ascension is expressed in hours of sidereal time, from west to east, counting from the point where the path of the sun in its northward course in declination crosses the equator. The point is termed the vernal equinox.

The sidereal day of 24 hours is approximately 4 minutes shorter than the ordinary mean solar day; a star will cross the meridian approximately 4 minutes earlier each succeeding day; on one calendar day each year a star will have a double meridian passage.

The chart is to be oriented facing south. The center of the field at noon on any date may be interpolated (roughly) between the marks for the dates as indicated. At 6 p. m., local mean time, the center of the field, or line for the meridian, will be six hours to the left; at 8 p. m., 8 hours to the left; both counting from the point for the noon of the date.

The interval between the time of a star's meridian passage and any other position in its diurnal circle is the star's sidereal hour angle, at the moment, and may count either to the east or to the west.

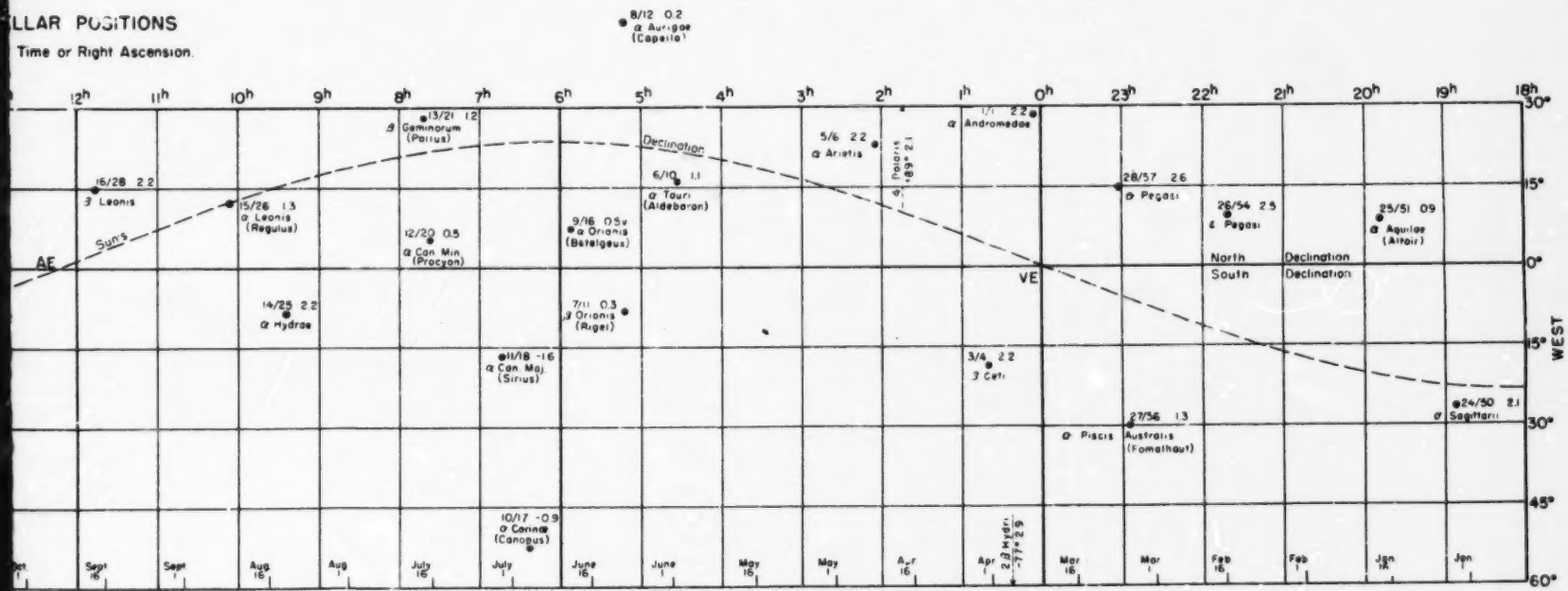
Anticipating the local mean time of an observation, a star's hour angle, at that moment, may be scaled (roughly) according to its position on the diagram to the east or to the west of the line for the meridian as placed for that date and time.

The calculations for the reduction of an observation are to be based upon the exact local mean time of the star's meridian passage for the date as ascertained from the tabulated data, from which the sidereal interval, or hour angle at the moment of the observation, may be derived, and the latter converted into the equivalent mean time interval.

It may be noted that the time factor does not enter into the equation for azimuth in the reduction of an altitude observation.

LLAR POSITIONS

Time or Right Ascension.



idian at noon on the dates as shown

The Ephemeris
Bureau of Land Management: *Facing p. 30.*

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